Annual Extra Number

AUTOMOBILE ENGINEER

LONDON SHOW REVIEW

Vol 49 No 12 25 NOVEMBER 1959 PRICE 3s 6d

It's a more profitable move with

DURALUMIN &

'MG 5' bodywork

REGD. TRADE MARK

Photograph by courtesy DUPLE MOTOR BODIES LTD.

Bigger loads—lower running costs—bigger profits!

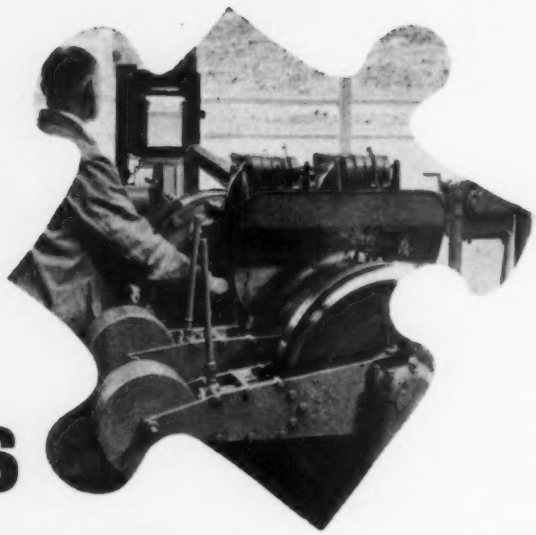
Our Technical Sales Section will gladly help you to take full advantage of 'Duralumin', 'MGs' or any other James Booth light alloys, for modern motor vehicle bodywork

DELTA GROUP

Extrusions, large forgings, plate, sheet, strip, tubes and wire in brass and copper, as well as light alloys

James Booth

JAMES BOOTH & COMPANY, LIMITED

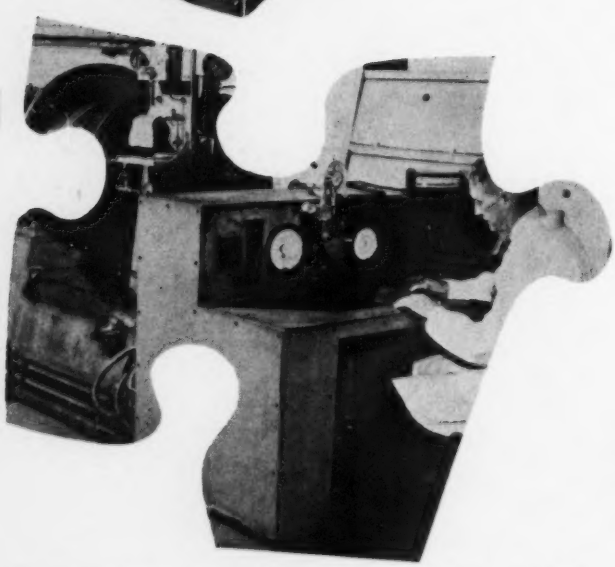


It's no puzzle to B.B.A.!

How to produce a first-class brake liner is certainly no puzzle to B.B.A. Over fifty years of experience, backed up by one of the most up-to-date Research and Development Laboratories in the country ensures that MINTEX High Performance Brake Liners are consistently second to none.

The pattern of research and testing at B.B.A. fits smoothly together to solve the braking problems of the present and to be ready with the answers for problems of the future.

That's why we say with confidence



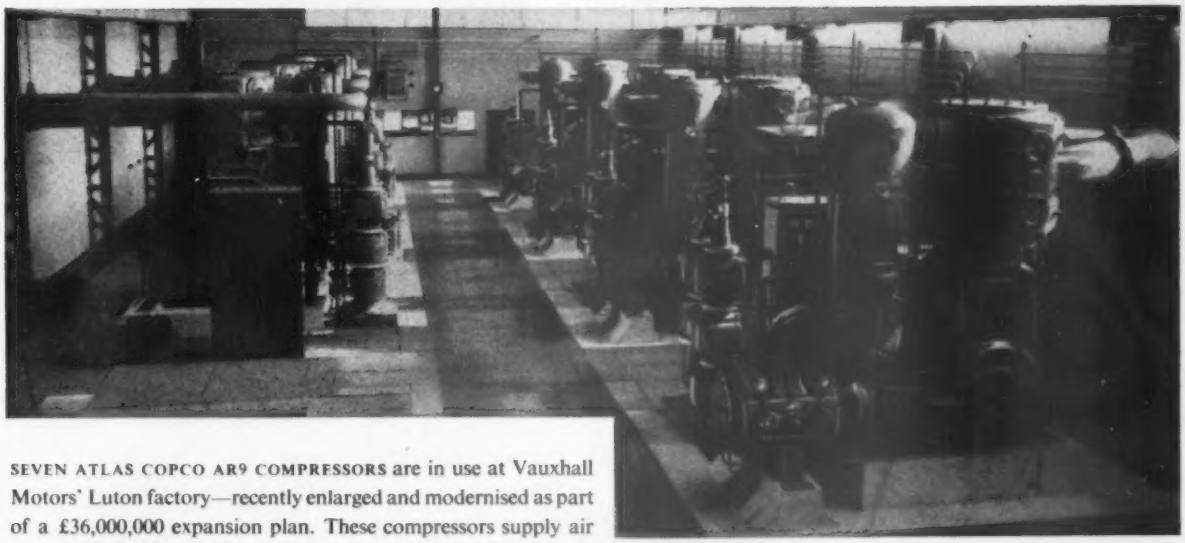
You can rely on

MINTEX

HIGH PERFORMANCE BRAKE LINERS

MINTEX BRAKE AND CLUTCH LINERS AND DISC BRAKE PADS ARE MANUFACTURED BY BRITISH BELTING AND ASBESTOS LIMITED, CLECKHEATON, YORKSHIRE

Compressed Air at work in Vauxhall's Luton extension



SEVEN ATLAS COPCO AR9 COMPRESSORS are in use at Vauxhall Motors' Luton factory—recently enlarged and modernised as part of a £36,000,000 expansion plan. These compressors supply air to the body fabrication shops, press shops and other departments, providing power for clutch movements; resetting presses; mechanical handling; loading; welding; and mixing and spraying paint. In addition air is supplied for a number of pneumatic tools such as wrenches, grinders, drills and hoists.

ECONOMIC INSTALLATION

The AR9 compressors were installed at a cost below that estimated for other compressors of the same capacity. The reason being that the AR9 occupies 25% less floor space than is normally required —with consequent economies in compressor house costs.

HIGH OUTPUT

The Atlas Copco AR9 combines thorough reliability of performance with unusually high output per horsepower consumed. The installation at Vauxhall's has a total output of 22,540 c.f.m.

A COMPLETE RANGE OF COMPRESSED AIR EQUIPMENT

Atlas Copco manufactures portable and stationary compressors, rock-drilling equipment, loaders, pneumatic tools and paint-spraying equipment. Sold and serviced by companies or agents in ninety countries throughout the world.

Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Contact your local company or agent or write to Atlas Copco AB, Stockholm 1, Sweden or **Atlas Copco, (Great Britain) Limited**, Maylands Avenue, Hemel Hempstead, Herts. C.16

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broaching

Broaching round holes in cross members.

Capacity: 2½/15 tons, stroke: 24/30/36 inches. These machines can be supplied for push, pull or surface broaching.

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AUTOMOTIVE PRODUCTS

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AUTOMOTIVE PRODUCTS ASSOCIATED LTD

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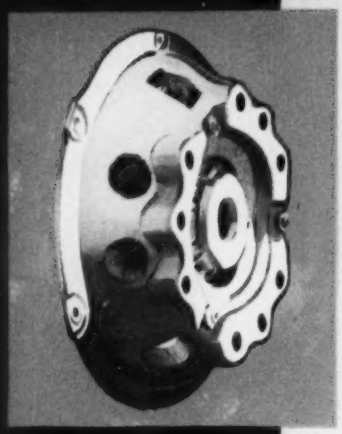
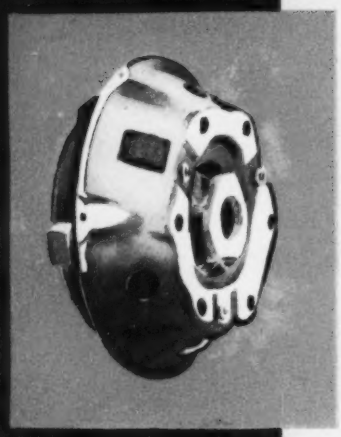
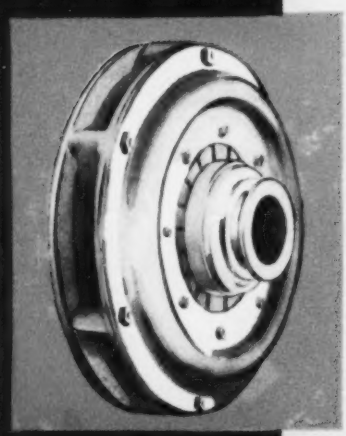






THE WIDEST RANGE OF

The Borg & Beck A-type clutches range from 6¼″ to 11″, in addition to the range of commercial vehicle clutches. The illustration shows the 9″ clutch.

The 7¼″ Twin-plate clutch has a high torque capacity within a small overall diameter, and is suitable for higher rotational speeds. It follows normal Borg & Beck design, with a pressed steel cover and knife-edged struts for the release lever. It has two driven plates whose inertia is less than that of a single plate of equivalent capacity, reducing the loads on the synchro-mesh clutches and assisting rapid gear changes. The fly-wheel is recessed to take the second pressure plate, permitting the use of standard Borg and Beck parts.

The 8″—8½″ strap-drive clutch embodies the successful self-centring frictionless strap drive to the pressure plate. The clutch can be installed in the same size bell housing used with the standard Borg & Beck 8″ A.6 clutch, and the same types of flywheel and release bearing can be used. According to the nature of the application, the clutch can be used with either an 8″ or an 8½″ driven plate.

The 7¼″ 'Diaphragm' type racing car clutch has been designed expressly for competition and racing use and has a high torque capacity, with low-inertia driven plates. The clutch is small in overall dimensions, light in weight, and is available with either 1, 2, 3 or 4 driven plates. Suitable for high r.p.m. and interchangeable as a unit with twin and triple plate Borg & Beck clutches previously used for racing.

BORG

BORG & BECK COMPANY LIMITED

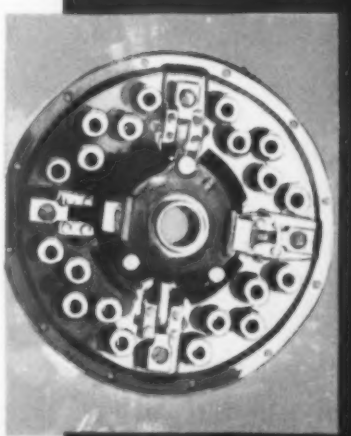
FRICTION CLUTCHES

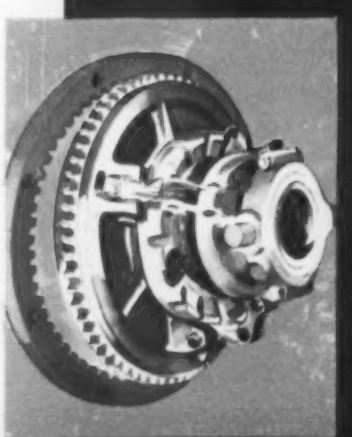
The integral clutch and power take-off for tractors comprises two clutches mounted in tandem. The clutch nearest the flywheel transmits the drive to the rear wheels through the usual splined clutch shaft; the other clutch provides a power take-off for driving a combine, baler, mower or other machine, and transmits its power through a hollow splined shaft. In most cases a separate engine for driving implements is rendered unnecessary. Each clutch has an independent throw-out fork with ball-thrust bearings. Made in two sizes, 10″ and 11″.

Lockheed strap-drive clutches for heavy vehicles follow the general basic design with pressed steel cover, knife-edged release levers and heavy pressure plate. The strap drive is of especial advantage in the heavy type of vehicle where the absence of mechanical wear and tear between the pressure plate and the housing maintains the quietness of the clutch and also its running balance. These clutches are available in a range of torque capacities, sizes available are 12″, 13″, 14″ and 15″.

Borg & Beck R-type clutches are suitable for very heavy torques and are made in two sizes, 16″ and 18″, with single or double discs.

Rockford over-centre clutches and power take-offs are made in a range of sizes. Their freedom from running thrust, both in the engaged and disengaged position, is of great value in many applications.





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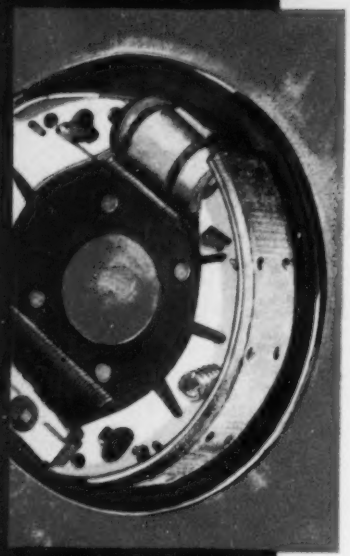

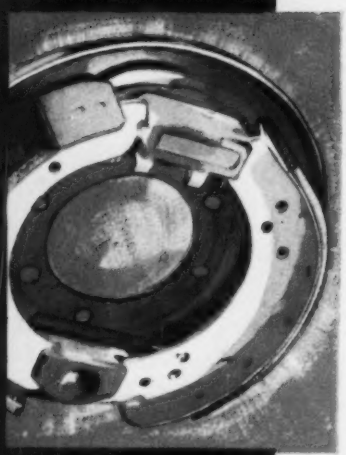

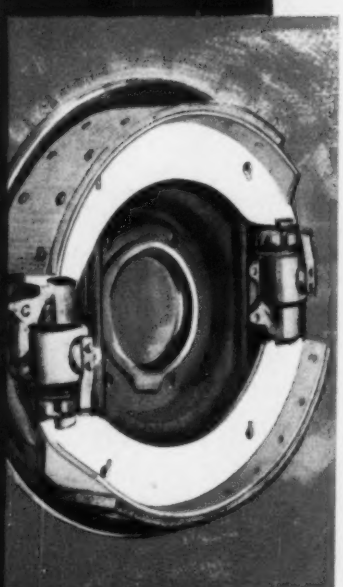

LOCKHEED

DRUM BRAKES

Lockheed drum brakes incorporate some valuable detail improvements. These new brakes are made in four sizes: 7″, 8″, 9″ and 10″. The 7″ has leading and trailing shoes for all wheels; the 8″, 9″ and 10″ have two-leading shoes on the front, and leading and trailing shoes on the rear.

The separate hand-brake lever is arranged to suit either fore-and-aft or transverse travel, thus conforming to the requirements of I.R.S., and has improved booting.

The drawing shows a rear brake; the wheel cylinder is fixed to the backplate and has two opposed pistons and improved sealing arrangements.

Other features of these brakes include interchangeability of all eight brake shoes.

MECHANICAL BRAKES

Lockheed mechanical brakes are intended for use as primary brakes and steering brakes for equipment such as farm tractors, farm machinery, farm and industrial trailers and for caravans. They provide a light, powerful and inexpensive braking system giving controlled safety with maximum economy and negligible maintenance. They are intended for direct actuation or for remote actuation by vacuum and air systems. The brakes are of the leading and trailing shoe type, with centre-pull actuation, and are made for 7″, 8″, 9″ and 10″ drums.

BRAKES FOR COMMERCIAL VEHICLES

Lockheed 16″ brakes are expressly designed for trucks of 5-6 ton payload, with 16″ x 2½″ two-leading-shoe front brakes and

LOCK

Leadership in high

BRAKING

16″ x 3½″ or 4¼″ wide rear brakes. For lighter trucks, the Lockheed 12″ or 14″ x 2½″ two-leading-shoe front brakes in conjunction with 14″ x 2½″ rear brake with transverse wheel cylinder are available.

DISC BRAKES

Lockheed disc brakes, of simple and straightforward design, are giving outstanding service on a wide range of types of car and have had a magnificent reception in the press on account of their consistent performance, stability and non-fading properties. Available as front or rear in three sizes, light, medium and heavy, to cover all applications.

POWER BRAKING

The Lockheed vacuum power-braking system is accepted as the finest of its kind and gives progressive servo assistance, yet it retains the feeling of intimate control by the driver. Its installation is extremely simple and the units are of great reliability, light in weight, and impose no reactions upon the mountings. For heavier vehicles the Lockheed Hydrovac system is made in several sizes of units, some single and some twin; these cover every requirement.

LIMITING VALVE

The Lockheed pressure-limiting valve, shown here, can be used with disc or drum brakes and is most effective in controlling the share contributed by the rear-braking system on cars in which weight distribution or transfer is such as to make its use desirable.

LOCKHEED
HYDRAULIC BRAKE COMPANY LIMITED
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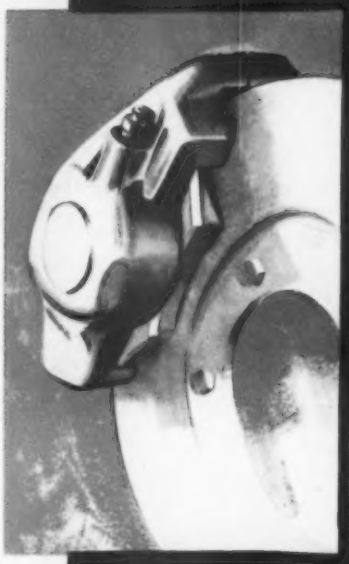


HEED

REGD. TRADE MARKS: LOCKHEED, HYDROVAC

performance braking

'MICRONIC' LUBRICATING OIL,

FULL-FLOW FILTERS FOR LUBRICATING OIL

Purolator 'Micronic' full-flow filters have proved to be of the greatest value in protecting engines against oil-borne abrasives, and their use is greatly extending.

Their high efficiency is due to the plastic-impregnated paper element, pioneered by Purolator, which provides a great area of filter surface of closely controlled texture.

These filters are made in a range of sizes with both single and twin bowls, the latter incorporating two 'Micronic' elements in parallel, each with its own relief valve.

FILTERS FOR FUEL OIL

are made in single and twin types giving a wide range of flow capacity. Twin types are also available with the Purolator metal-element filter for the first stage and the 'Micronic' element for the second stage, the majority of the impurities being arrested by the first stage.

AIR FILTERS

Purolator also pioneered the 'Micronic' air filter and its use on motor car applications.

Considerable experience has been obtained therefore as

PURO

AUTOMOTIVE PRODUCTS COMPANY LIMITED,

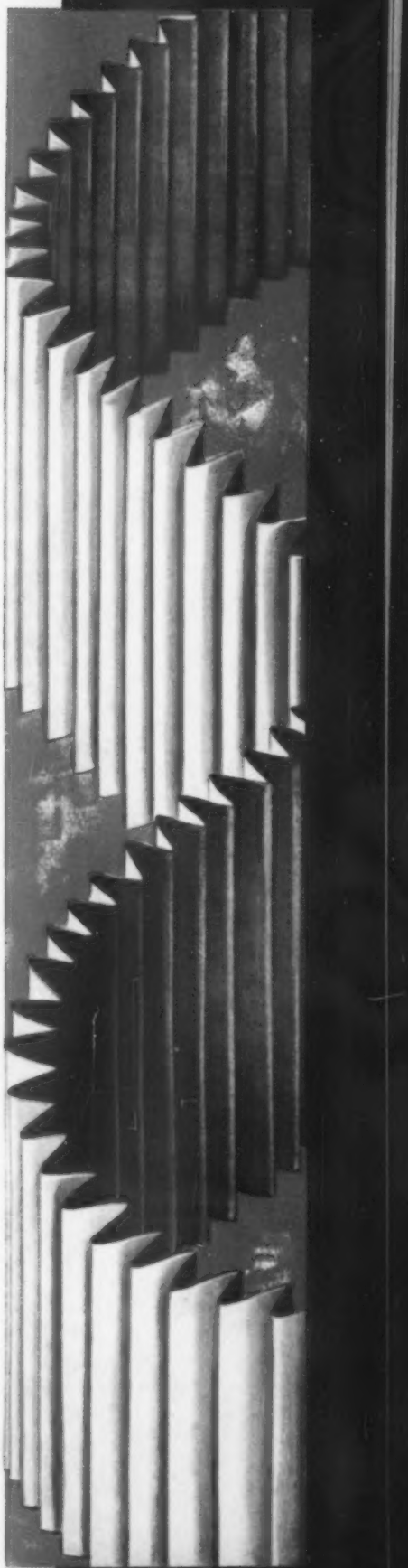
FILTERS FOR
DIESEL FUEL, AIR

to the size and capacity necessary to give a satisfactory performance without affecting either fuel consumption or power, when operating in various dusty localities throughout the world.

The dry type air filter has the following advantages:

* POSITIVE FILTRATION AT ALL ENGINE SPEEDS
* COMPLETE ENGINE PROTECTION REGARDLESS OF OPERATING CONDITIONS
* EASY INSTALLATION AND SIMPLE, QUICK ELEMENT SERVICING
* ECONOMICAL AND WEIGHT SAVING

Other 'Micronic' filters: the success of the 'Micronic' plastic impregnated paper element filters has led to its adoption in Purolator filter-separator units arranged for large volume operation and invaluable for separating water and other impurities from fuel for aircraft and industrial use.



PUROLATOR

REGD. TRADE MARKS: PUROLATOR, 'MICRONIC'

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BALL JOINTS
for
SUSPENSION SYSTEMS
and
STEERING CONNECTIONS

Thompson self-adjusting steering joints eliminate backlash, reduce friction and provide long trouble-free life. They are available in a wide range of sizes, for vehicles of all types and for use on side rods, centre rods, drag links and tie-rods.

In addition to the standard range there are self-lubricating types which eliminate maintenance during the life of the car.

Thompson suspension joints simplify steering and suspension layouts and obviate the need for adjustment.

Thompson

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FROUDE PATENT G type

Retaining the well-tried and long-established Froude power-absorbing elements, plus the Froude reputation for scientific accuracy of readings, this revolutionary, small, compact

HYDRAULIC *Dynamometer*

represents a notable advance in Dynamometer design that has only been achieved by long experience as specialists in Engine Test Plant.

- WIDE RANGE OF POWER & SPEED
- REVERSIBILITY
- LOAD THROW-OFF DEVICE
- COMPACTNESS
- MINIMUM MAINTENANCE
- SIMPLICITY
- LONG LIFE

The Froude G.4. Dynamometer deals with powers up to 350 B.H.P. at 2000/6000 r.p.m. and is only 26" (660 mm) between half-coupling faces and 37½" (950 mm) wide.

The control system has the great advantage of allowing a very wide range of powers and speeds on any size of G. type Dynamometer, so that large and small engines can be tested.

HEENAN & FROUDE LIMITED

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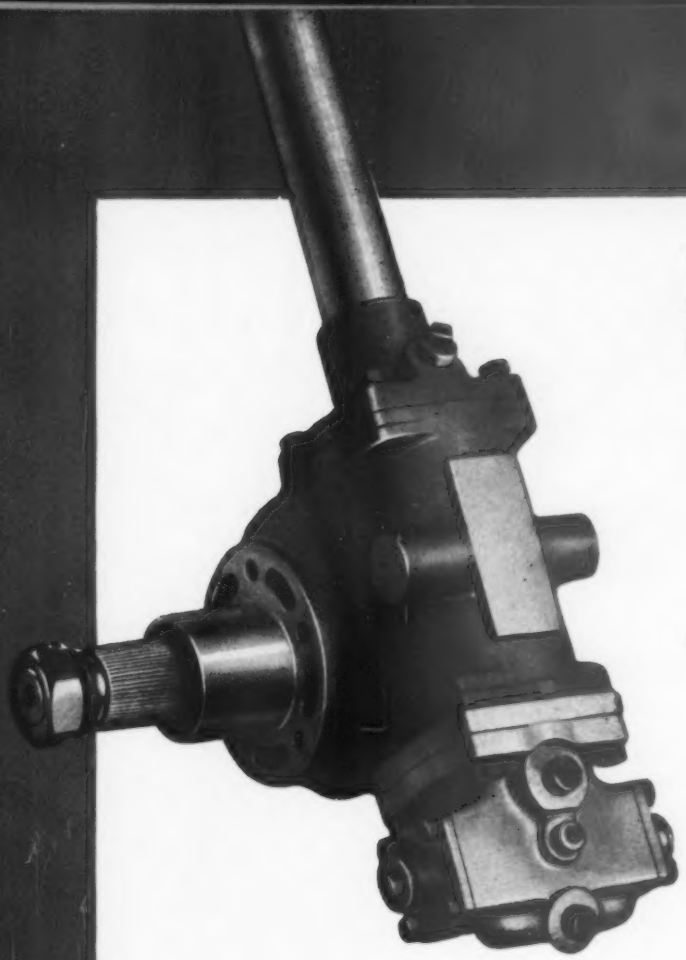

Interchangeable, on the same mounting, with the standard Marles manual gear unit.

THE TYPE 3 'UNIVERSAL' UNIT

Illustrated above is the Type 3 'Universal' steering gear which incorporates the hydraulic control valves mounted upon our type '861' manual gear. This is for use with a separate power pump and with power cylinders operating on the steering linkage. Further particulars will be sent on request.

ADAMANT ENGINEERING CO. LTD.,
THE AERODROME, WOODLEY, Near READING.
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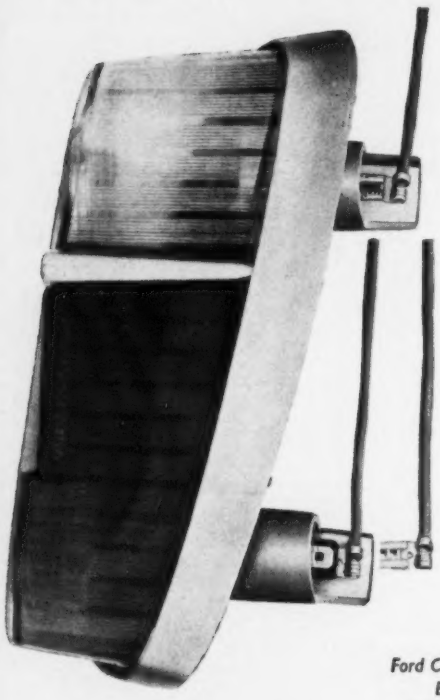
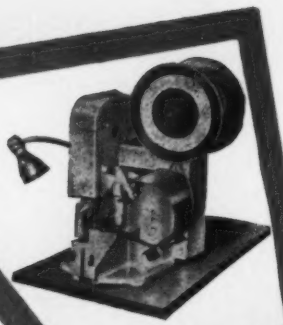


Thames Van rear lamp assembly



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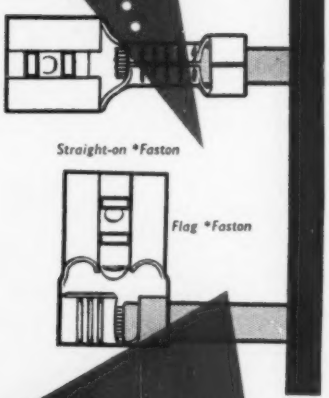

*Straight-on *Faston*

*Flag *Faston*

Ford Consul de Luxe — Electrical system uses both straight-on and flag Fastons*

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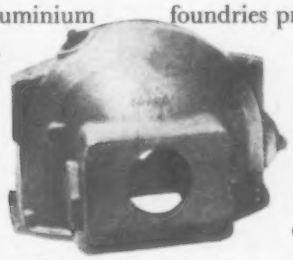
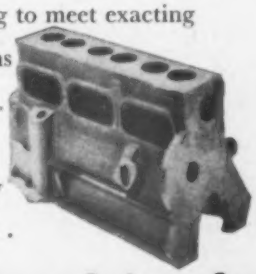
Quality castings in grey iron, aluminium alloys and Mazak are supplied in large quantities for a wide range of industries, including the major part of the British motor industry. Our iron foundry has five fully mechanised units designed to handle varying weights and sizes in order to provide maximum economies in mass production. A large floor-moulding section can handle castings up to 5 tons weight. The aluminium foundries produce a large tonnage by sand casting, gravity die casting and pressure die casting to meet exacting conditions of service.





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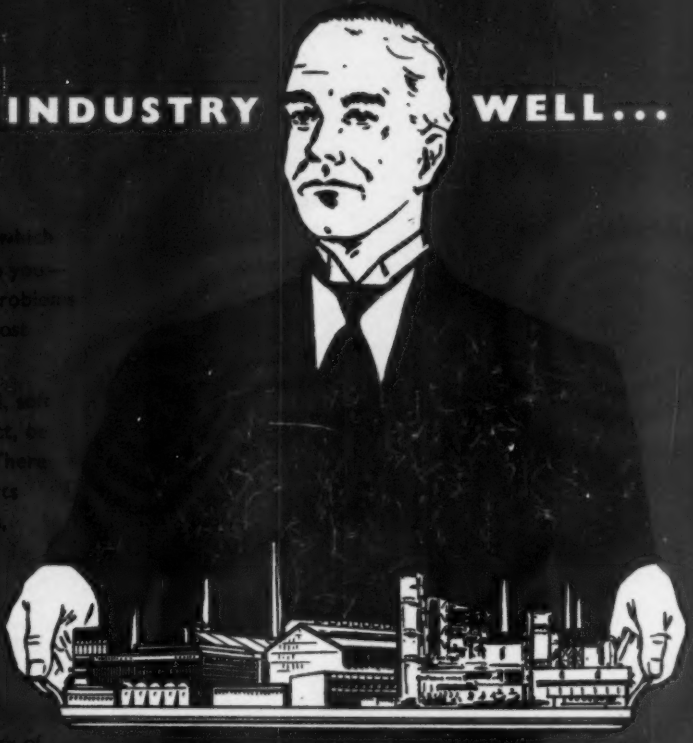

If we could list the purposes for which Meadowfelt is used, it would amaze you—and give you ideas! It is solving problems and effecting economies in almost every industry you care to name.

Meadowfelt can be thick, thin, solid, soft, resilient or resistant—it can, in fact, be made to your exact requirements. There is no limit to the variety of cut parts which can be produced—washers, gaskets, anti-vibration blocks, pads for polishing, strips for channelling, shapes for packing, to name a few.

You know all about felt!—then the chances are that the price, quality and quick delivery of Meadowfelt will make an enquiry well worth while. Why not ask us to send a representative?

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INCREASED PRODUCTIVITY

impact wrench

SIZE 24

Basically designed as a Nut Setting Tool, this Impact Wrench may be effectively used with the available attachments for screwdriving, tapping, drilling, grinding, wire-brushing or sanding.

Extra strong in design and construction this tool incorporates longer normal working life with minimum maintenance.

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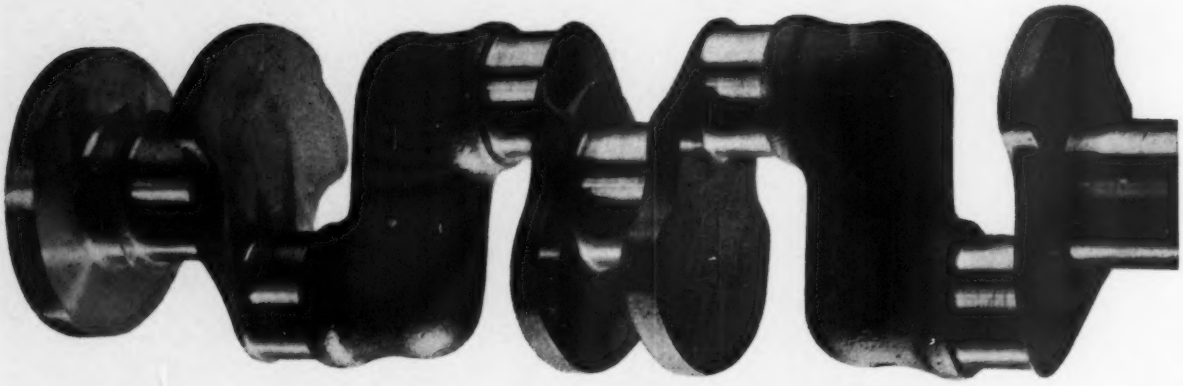

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precision	Machining allowances down to as little as 0.030" on journals and crankpins.
material	S.G. (nodular) iron ; min. tensile 35 tons p.s.i. Elongation 2-4%.
service	Prototype to production, from one of Europe's most highly mechanised foundries.

Dartmouth Auto Castings Ltd

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a new technical advance by

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gives even greater economy without loss of full throttle power

SOLEX LIMITED 223-231 MARYLEBONE ROAD LONDON N.W.1

For the brilliance that lasts and lasts . . .

TRUBRITE Stainless Steel

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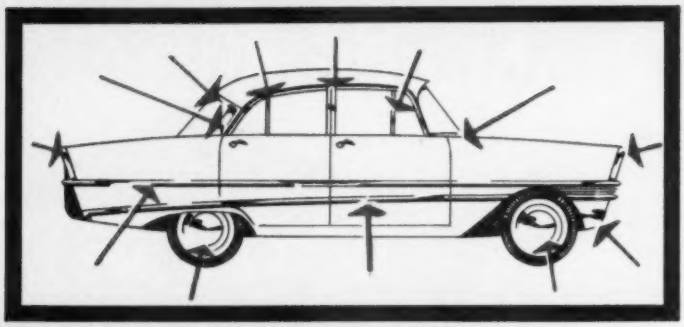
THE MOTORIST says:

Trubrite keeps its beauty so much longer than other trim materials, and saves me work in cleaning. It resists scratches, never corrodes, and maintains the value of my car.



THE DEALER says:

Trubrite, with its time-proof brilliance, strength, and easy maintenance, makes an instant appeal in the showroom. It also helps me clinch those vital marginal sales.

Sparkling beauty enhances styling of modern cars
Cannot rust, peel or chip. No pitting.
More strength—resists scratches and denting.
Bright right through.
Easy to clean (using only soap and water)
Time-proof brilliance keeps up value of car.
Already adopted for many parts both outside and in by leading manufacturers, such as Vauxhall, Morris, Wolseley, Riley, etc.

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LEE of Sheffield

ARTHUR LEE & SONS LIMITED

TRUBRITE STEEL WORKS · MEADOW HALL · SHEFFIELD · Telephone: Sheffield 387272
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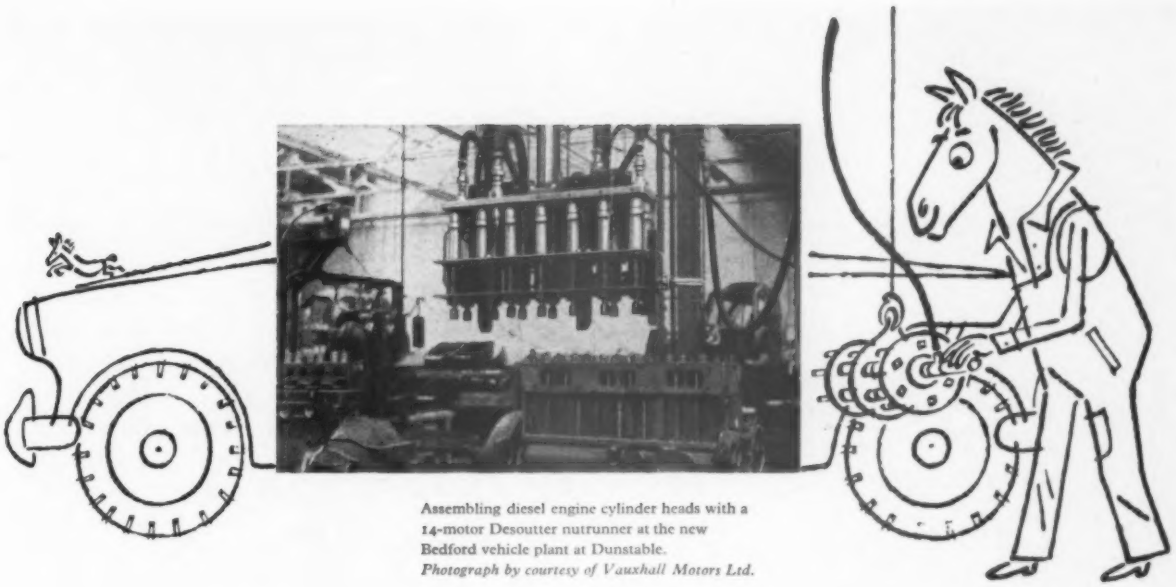
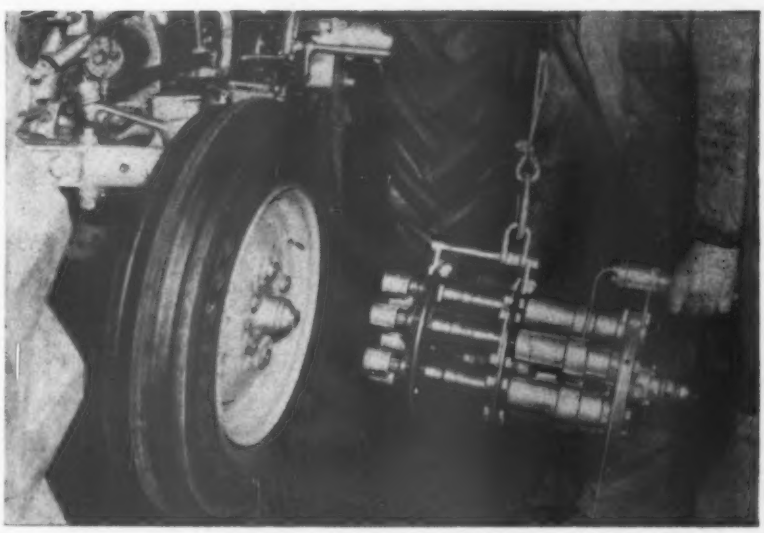


Assembling diesel engine cylinder heads with a 14-motor Desoutter nutrunner at the new Bedford vehicle plant at Dunstable.
Photograph by courtesy of Vauxhall Motors Ltd.

Desoutter in the Motor Industry

Without Desoutter power tools there would be no mass production. You may disagree, but that's *our* story and *we're* sticking to it. Come to think of it, do you know anything as fast, as reliable, as *non-stop* as a Desoutter power tool? Neither do we.

Our range of pneumatic and electric tools is nothing if not wide. But should you find a gap, we'll do our best to fill it for you. In certain cases we're prepared to produce an entirely new tool for a specific job. Write today for further details of Desoutter tools for the motor industry.



A six-motor multiple nutrunner used on the wheel assembly of Ferguson tractors.
Photograph by courtesy of Standard Motors Ltd.

Desoutter pneumatic and electric tools put power into your hands

Desoutter Bros. Limited, The Hyde, Hendon, London, N.W.9.
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CAC300

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FOR HIGH PRODUCTION

The Standard Motor Co. Ltd., Coventry, is only one of scores of factories where ARCHDALE special drilling and milling machines, as well as automatic transfer lines, are contributing to reduced costs, improved output and quality.

If you are producing components on a large scale, involving drilling, milling, tapping, boring or spot-facing, or any combination of these operations, ARCHDALE can certainly show you the way to lower costs.

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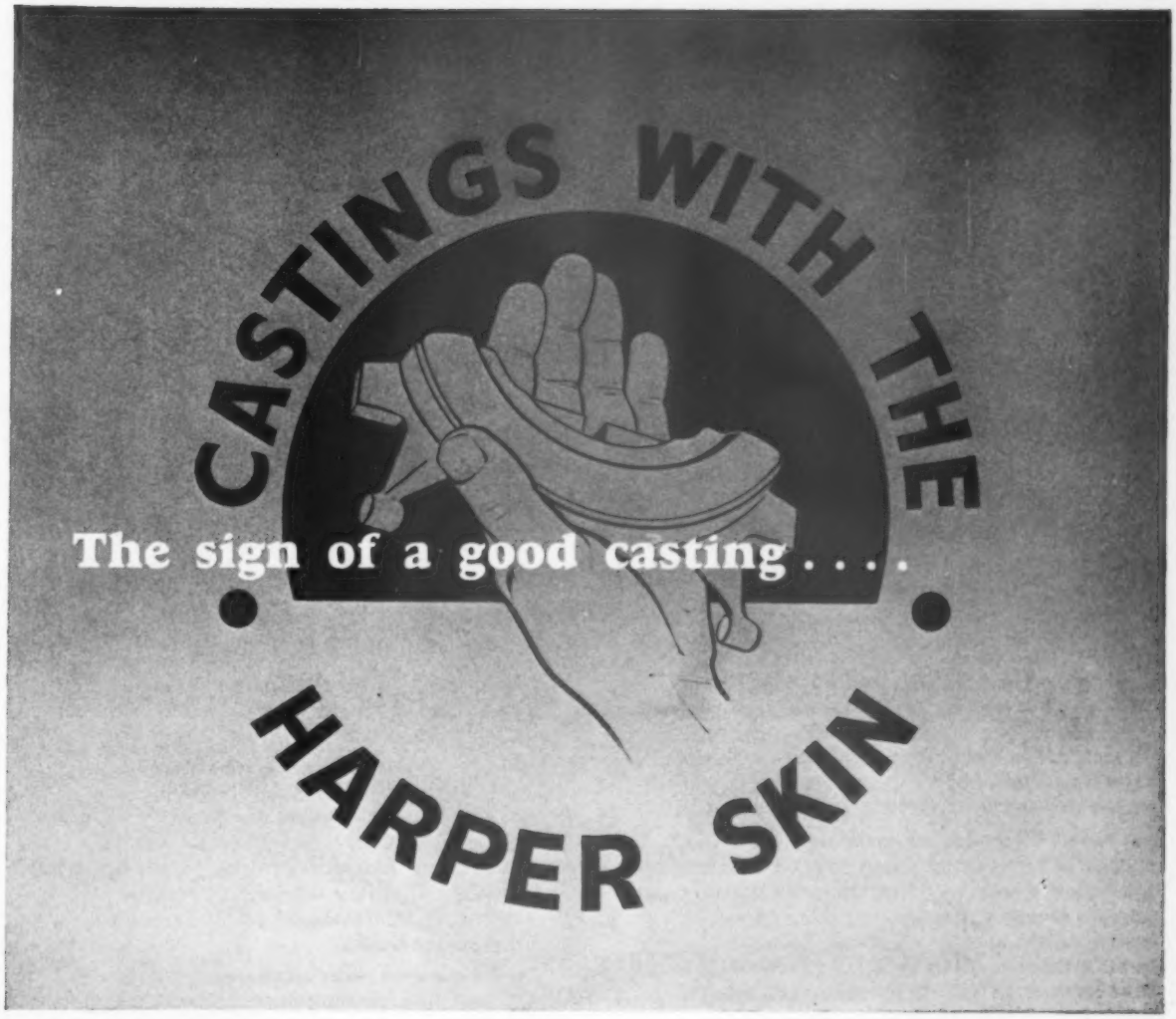

At every stage of production in Harper's modern works, much care and attention is given to ensure that castings are of the highest quality—a quality for which Harpers are famous. "Castings with the Harper Skin" is the sign of *good* casting and, what is just as important, Harpers are equally confident about the condition of the casting *under* the skin.

Harper quality covers Grey Iron, Spheroidal Graphite Iron (Mond Nickel Licence) and Meehanite castings. Metal pressings, machining, enamelling and sub-assembly work. Also makers of the famous Beatrice Oil Heaters and Harper Housewares.
The word MEEHANITE is a registered trade mark.

HARPER CASTINGS

Please write for our chart, which gives technical information on our mixtures

JOHN HARPER & CO. LTD. WILLENHALL STAFFS

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FOUNDED 1790

H.660

This is Tecalemit isn't it?

TECALEMIT—LUBRICATION, of course. You see the Tecalemit target and arrow sign and take the car in for lubrication service. Grease pumps, pipes, lifts, oil dispensers, air compressors—everything's Tecalemit, right down to the grease nipples. So it's simple: Tecalemit stands for Lubrication.

But Tecalemit stands for filtration
In spite of high compressions, greater loadings and higher speeds, modern car engine bearings can tolerate almost anything—anything except foreign bodies in their oil. Thus the Tec-element: an oil filter element of astonishing efficiency. Most leading British engine manufacturers fit Tecalemit oil filters and so recommend Tec-elements as replacements. Sound advice!

But Tecalemit make precision nylon piping too
Nylon piping for automotive uses was once merely a Good Idea. If only you could use it, it would be cheap, vibration resistant, strong, supple, chemically inert and so on. But how could it be produced to precision limits? Tecalemit found the answer—a resounding and exclusive technical triumph. Nowadays such great names as Austin, Aston-Martin, Ford, Jaguar and Rover use a great deal of Tecalemit extruded nylon piping for fuel lines and vent pipes.

But Tecalemit are famous for oil firing
Oil firing: it takes you out of the automotive field and into the brickworks and kilns. Much tidier brickworks, of course: no heaps of coal and slag. Just pipe runs, control panels, high efficiency and low cost. Oil firing is becoming a major industry in itself—and Tecalemit one of its most prominent names.

But Tecalemit make a thousand other things
Grease guns, power pumps, hose reels, lifts, sprayers, washing units . . . automatic and multiple lubricating systems for machinery and vehicle chassis . . . air cleaners, breathers and ribbon elements (finest air filtration at lowest cost) . . . in fact, an amazing number of things that help keep industrial and automotive machinery washed, pressured, connected, controlled, raised, lowered, filtered.
Oh yes—and lubricated. For of course Tecalemit stands for lubrication.

TECALEMIT

the Authority on Lubrication – and much else besides!

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LEY'S

Tested at 2,500 p.s.i.

The illustration shows a valve body for use in hydraulic control equipment. The complex nature of this valve body involves a great deal of machining; at the same time high mechanical strength is an important factor, since the valves are used at a high working pressure and are tested at 2,500 p.s.i.

These considerations led to the choice of castings in 'Lepaz 35', a pearlitic malleable which combines excellent machinability with an ultimate stress of 33/38 tons sq. inch and an elongation of 6-8%.

LEY'S MALLEABLE CASTINGS CO. LTD., DERBY. TELEPHONE: DERBY 45671.

STRENGTH & RIGIDITY

LEY'S

SINTERED METALS

Ferodo give the facts

Sintered Metal Clutch Facings have very different physical properties from the familiar asbestos based facings, and in certain automotive applications give improved performance.

High Thermal Conductivity gives

* LONG LIFE
* MINIMUM DISTORTION
* COOLER RUNNING
* MINIMUM HEAT CHECKING

Ferodo Sintered Metals withstand

* HIGH TEMPERATURES
* HIGH OPERATING PRESSURES

Reduced ratio of static to dynamic friction coefficients leads to

* SMOOTH ENGAGEMENT

Ferodo Sintered Metal Types

SM.1 General purpose material for dry and oil immersed applications.

SM.2 For oil immersed applications requiring smooth, gradual engagement such as automotive automatic transmissions.

SM.3 Specially suited to dry, heavy duty applications such as engine master clutches on trucks and on tractor steering clutches.

SM.4 Is intended as a mating surface for use against other Ferodo sintered metals to protect costly parts from heat damage and wear.

SM.5 For oil immersed applications involving long slip periods such as seals and tension controlled clutches.

SM.6 For oil immersed applications where smooth engagement must be coupled with relatively high rating.

FERODO

Sintered Metal Clutch Facings

Write to us for further technical information and brochure

FERODO LIMITED · CHAPEL-EN-LE-FRITH *A Member of the Turner & Newall Organisation*

TORSIONAL VIBRATION DAMPER

TVD EXPERIENCE

UNIQUE because millions of Metalastik rubber-metal Crankshaft Torsional Vibration Dampers for world-famous petrol and oil engines have established a reputation of unfailing reliability and efficiency.

30 YEARS experience finds us in a constantly improving position to advise on torsional vibration and to provide the most suitable form of damper, bonded or non-bonded depending on duties.

DAMPERS ILLUSTRATED

Top: Combined damper and pulley for a petrol engine.

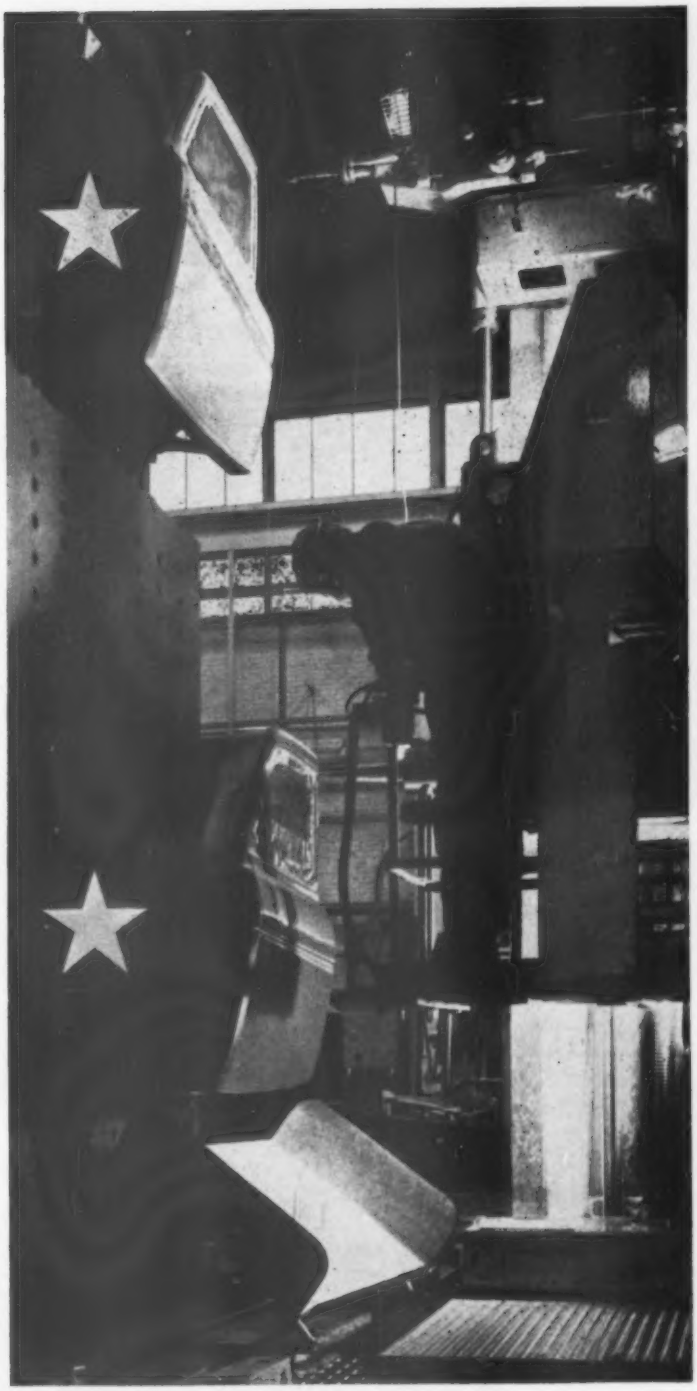
Left: Damper for 15-litre oil engine.

Right: Damper for high-performance 3.4-litre car engine.

METALASTIK

METALASTIK LTD., LEICESTER

Identical twins



This die-sinking machine is producing a metal punch for a car door outer panel, from a model made of Araldite epoxy resin. A stylus engages with the Araldite model, and its movements are repeated exactly in producing the metal punch. 4/5 weeks are required for the production of this punch, and the Araldite model retains its dimensional stability, in contrast with the distortion and fragility associated with the use of wood and plaster models. The Araldite unit is tough, durable and does not deteriorate in storage. Further information on numerous applications of Araldite in tool making is contained in a recent publication "Araldite for Tooling" manual B.T., which will be sent gladly on request.

Araldite epoxy resins are used

for producing patterns, models, jigs and tools.
for casting high grade electrical insulation.
for impregnating, potting and sealing electrical windings and components.
for producing glass fibre laminates.
as fillers for sheet metal work.
as protective coatings for metal, wood and ceramic surfaces.
for bonding metals, ceramics, etc.

Araldite

epoxy resins

Araldite is a registered trade name

CIBA (A.R.L.) LIMITED,

Duxford, Cambridge. Telephone: Sawston 2121

AP 462

Nylon

British Nylon Spinners Limited · 68 Knightsbridge · London SW1

for Motorway Mileage

This sturdy Seddon diesel, 'flagship' of Cyprien-Fox Ltd.'s fleet of vehicles, is on the nightly paint run between London and Birmingham. It carries 16 tons of paint at a time. Since January its Nylon-corded tyres have covered 23,000 miles—and when the firm's transport director examined them recently, he confessed he was amazed by their excellent condition.

Cyprien-Fox believe strongly that the main enemy of tyres is speed, and in this well-disciplined fleet blow-outs are now rare. But the future has severer conditions in store. With the coming of the motorways, traffic will move more freely, smoothly, quickly. Already this Seddon is tramping on the new London to Birmingham motorway. Even so, the transport director needn't worry. This is where nylon-corded tyres really pay off for firms like Cyprien-Fox. They run cooler and lose heat faster, so that speed is no longer the menace it was.

It's *Nylon* for lasting strength

Nylon is the toughest tyre-cord material in use today. Here are some of the ways in which nylon-corded tyres are setting new standards for reliability and economy:—

* Nylon can take it

Bumps, pot-holes, level-crossings, high kerbs mean nothing to nylon. Nylon-corded tyres take the most terrific punishment without turning a hair.

* Nylon is unaffected by water

Nylon-corded tyres are unaffected by water seepage through casing cuts and give the same high performance wet or dry. Nylon maintains its strength well and never rots.

* Nylon is best for flex resistance

Nylon stands up superlatively well to the bending and twisting to which all tyres are subjected. Nylon's flex resistance is better than that of any other tyre cord.

* Nylon means more remoulds

Nylon's outstanding strength, resilience and toughness mean that nylon-corded tyres can be remoulded time and again. In this way tyre-life is multiplied many times.

For a modest premium nylon-corded tyres can save you time, money and frustrating delays. For more information about them, please get in touch with your usual supplier. He will be happy to tell you *all* about them.

When one stops to think about it there are not many forms of transport that do not include Hardy Spicer Propeller Shafts and Universal Joints. In fact they tend to be taken very much for granted when people get round to talking about dependability, design, and performance. Take a look at the range of commercial vehicles depending on Hardy Spicer Propeller Shafts and Universal Joints and you will see what we mean.

HARDY SPICER

PROPELLER SHAFTS

product of the Birfield Group

HARDY SPICER LIMITED

CHESTER ROAD · ERDINGTON · BIRMINGHAM 24 · ERDINGTON 2191 (18 LINES)

Automotive Division of BIRFIELD INDUSTRIES LIMITED.

There is no substitute for a C.A.V. Paper Filter

Where else can you find a filter of such high efficiency with adequate service life? The C.A.V. fuel oil filter removes from the fuel a high proportion of the minute abrasive particles which wear the finely fitting parts of fuel injection pumps and injectors, and which pass through many filters. But with high efficiency it is inevitable that the filter element will become choked in time—its life depends largely on the effective filtering surface area. In the C.A.V. filter, this is 560 sq. inches—several times more than most other types, ensuring the longest life commensurate with adequate filtration.

Great care is taken in testing and checking C.A.V. paper filter elements during manufacture. Substitutes are frequently faulty and are no safeguard to fuel injection equipment.

WHY TAKE RISKS? The C.A.V. element is low in price—insist on the genuine article

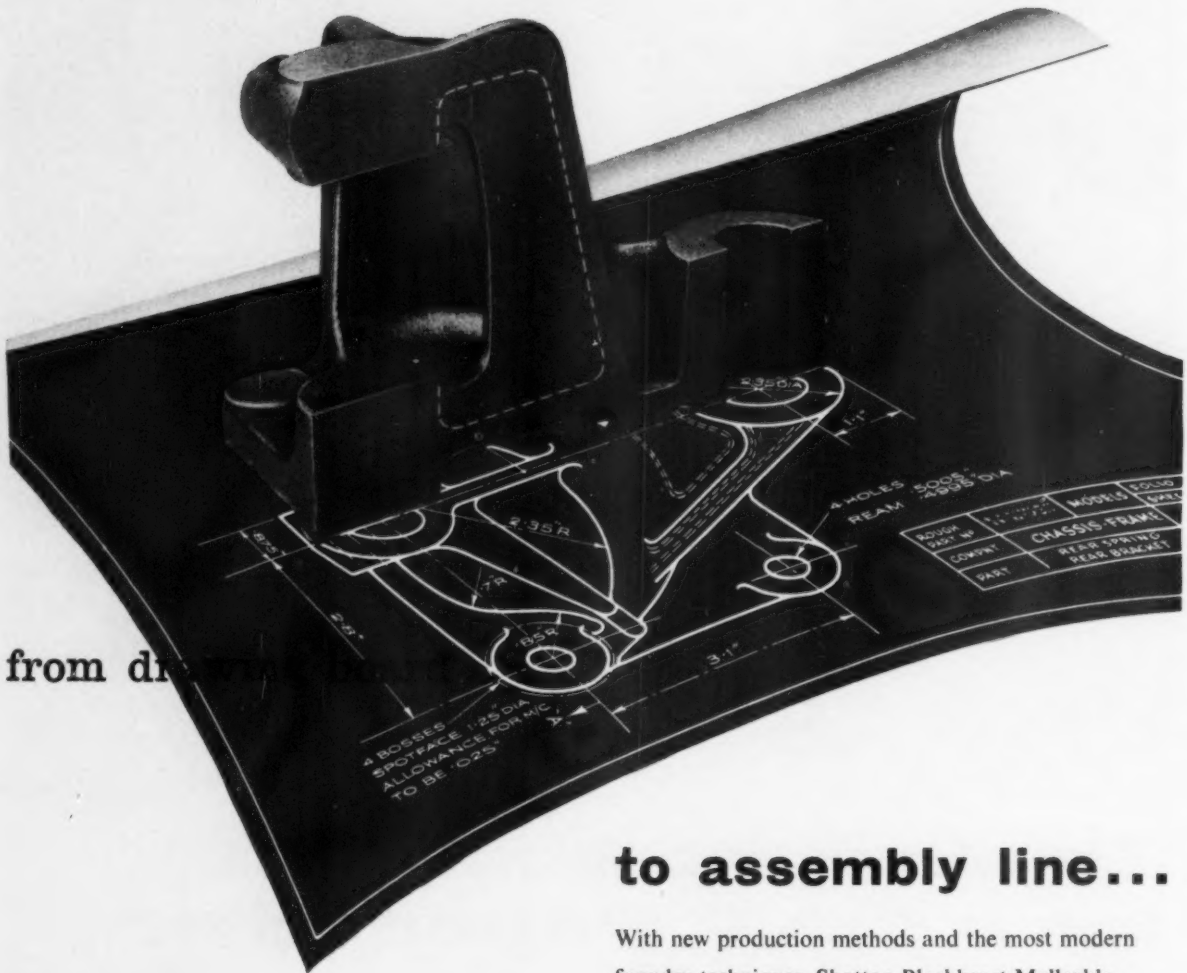
The World's Largest Manufacturers of

FUEL INJECTION EQUIPMENT

C.A.V. LIMITED, ACTON, LONDON, W.3.

AP 948

SHOTTON BLACKHEART MALLEABLE CASTINGS and PEARLITIC MALLEABLE CASTINGS



from di

to assembly line...

With new production methods and the most modern foundry techniques, Shotton Blackheart Malleable Castings have found many new applications in the automotive industry. On design problems and all technical and production matters our consultation, backed by 64 years' experience, is readily available to you.

SHOTTON BROS. LIMITED

MANCHESTER STREET FOUNDRY

OLDBURY · BIRMINGHAM · PHONE: BROADWELL 1631

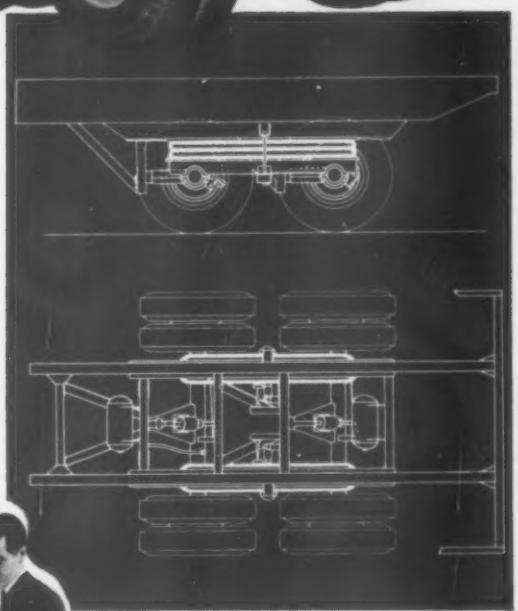
(and new foundry at Halesowen)

Member of the Birfield Group

This company participates in the research, technical and productive resources of the Birfield Group, which includes Hardy Spicer Ltd., Laycock Engineering Ltd., Kent Alloys Ltd., Forgings and Presswork Ltd., and many other famous firms.

Points of suspension

Automatic platform levelling and height control; constant ride characteristics under all load conditions; reduced tyre wear; longer life than orthodox springs . . . some of the reasons why Andre Rubber Pneumatic Suspension systems are a "must" for the progressive trailer designer. Ask Andre Rubber for full details.



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A SILENTBLOC COMPANY

ANDRE RUBBER COMPANY LIMITED KINGSTON BY-PASS SURBITON SURREY

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INNER SEAL

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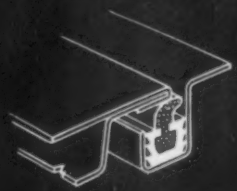
QUARTER WINDOW SEAL



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- ★ NO CLIPS
- ★ FOR PLAIN FLANGE
- ★ SUBSTANTIAL COST SAVER

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649,137	29,215/55
708,245	2,922/55
702,743	34,064/55
655,299	36,674/55
700,254	36,675/55
707,757	8,160/56
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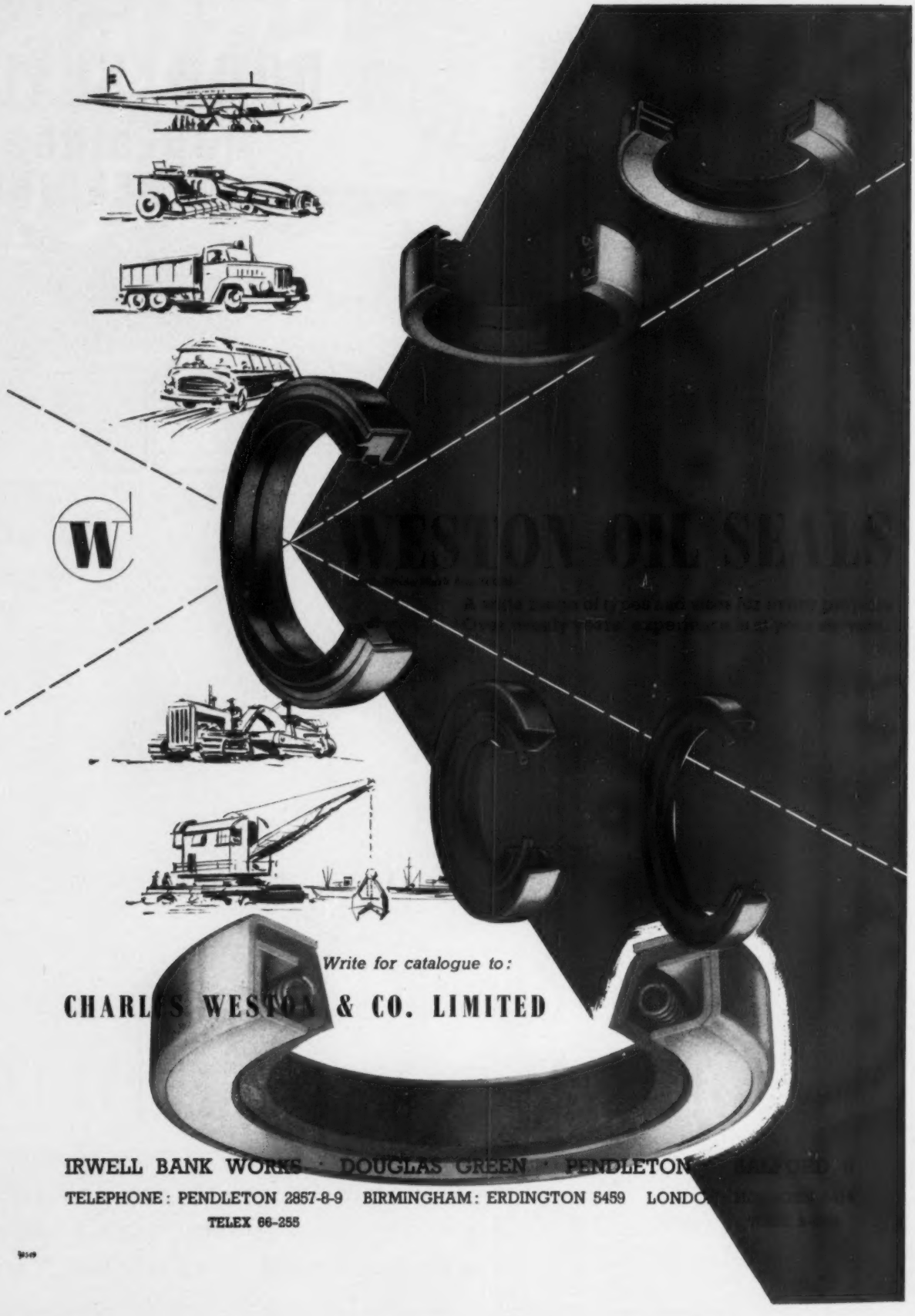
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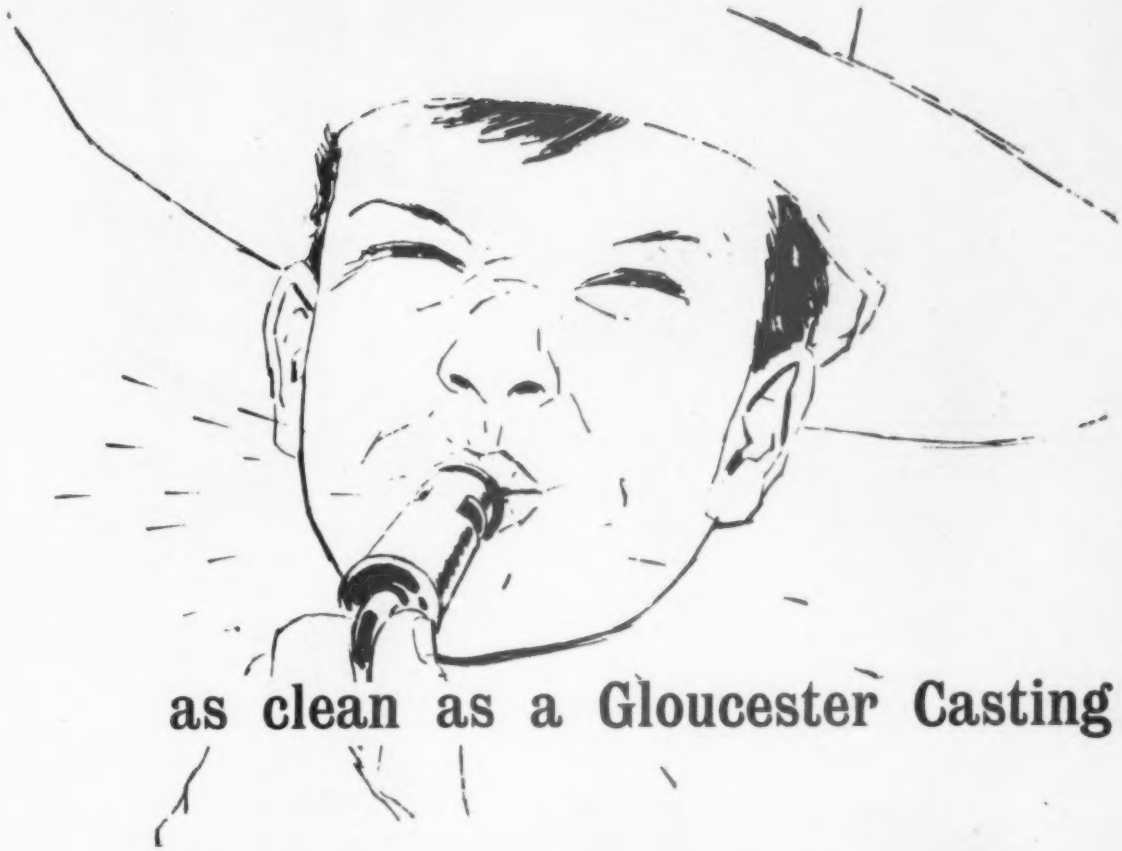


as clean as a Gloucester Casting

Brake shoe for small vehicle in Malleable Iron.

Bearing bracket in Malleable Iron. Weight 3¼lbs.

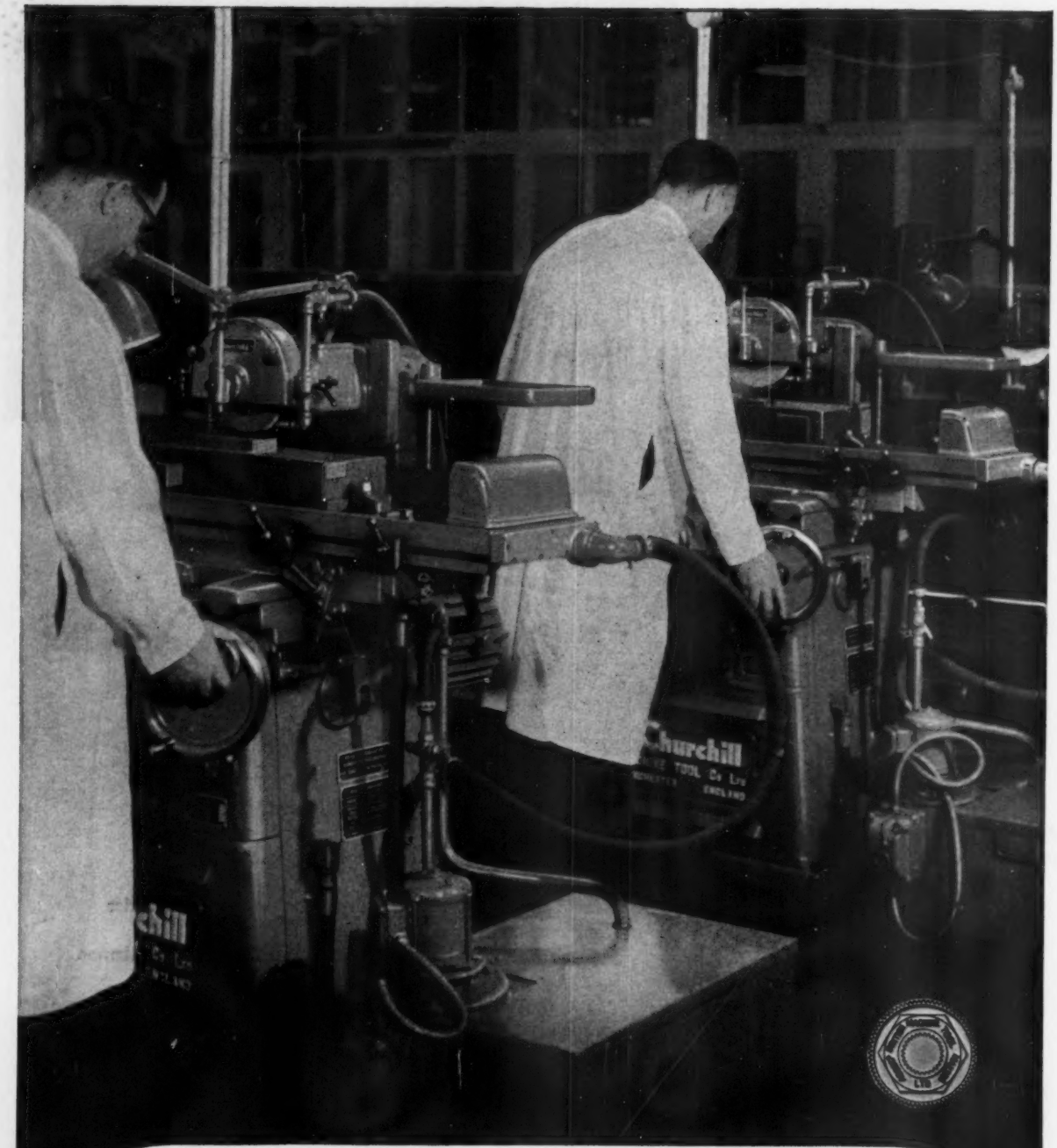
"As clean as a Gloucester Casting" means that Gloucester malleable iron castings are of high definition, true to pattern, cleaner and smoother because of better sand practice and better fettling.
Mould and core sands and their bonding additives are under constant laboratory supervision, even the very sand grains are sized and numbered, and consistency and distribution of sand are strictly controlled by a continuous mechanical unit. The high refractory characteristics prevent sand "burn-on" at re-entrant angles, thus greatly increasing the life of cutting tools during the machining process. The new elevator-type electric furnace anneals in 48 hours —instead of the usual 7 days. It also allows greater control of the component during annealing, resulting in uniformity of metal, greater strength, and resistance to impact.

A typical Gloucester Malleable specification.

Gloucester Blackheart Malleable	*Gloucester Lamellar Pearlitic Malleable*
Elongation .. 18%	Elongation .. 5%
Yield Point .. 12 tons	Yield Point .. 24 tons
Tensile Strength 25 tons psi	Tensile Strength 35 tons psi

GLOUCESTER

Gloucester Foundry Ltd., Emlyn Works, Gloucester · Telephone: Gloucester 23041 · Telegrams: 'Pulleys' Gloucester
(A subsidiary of the Gloucester Railway Carriage & Wagon Co. Ltd.)



Grinding Components for Marine and Aeronautical Equipment to Fine Limits at Sperry Gyroscope Co. Ltd. on

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MODEL NB 18 x 6 IN.
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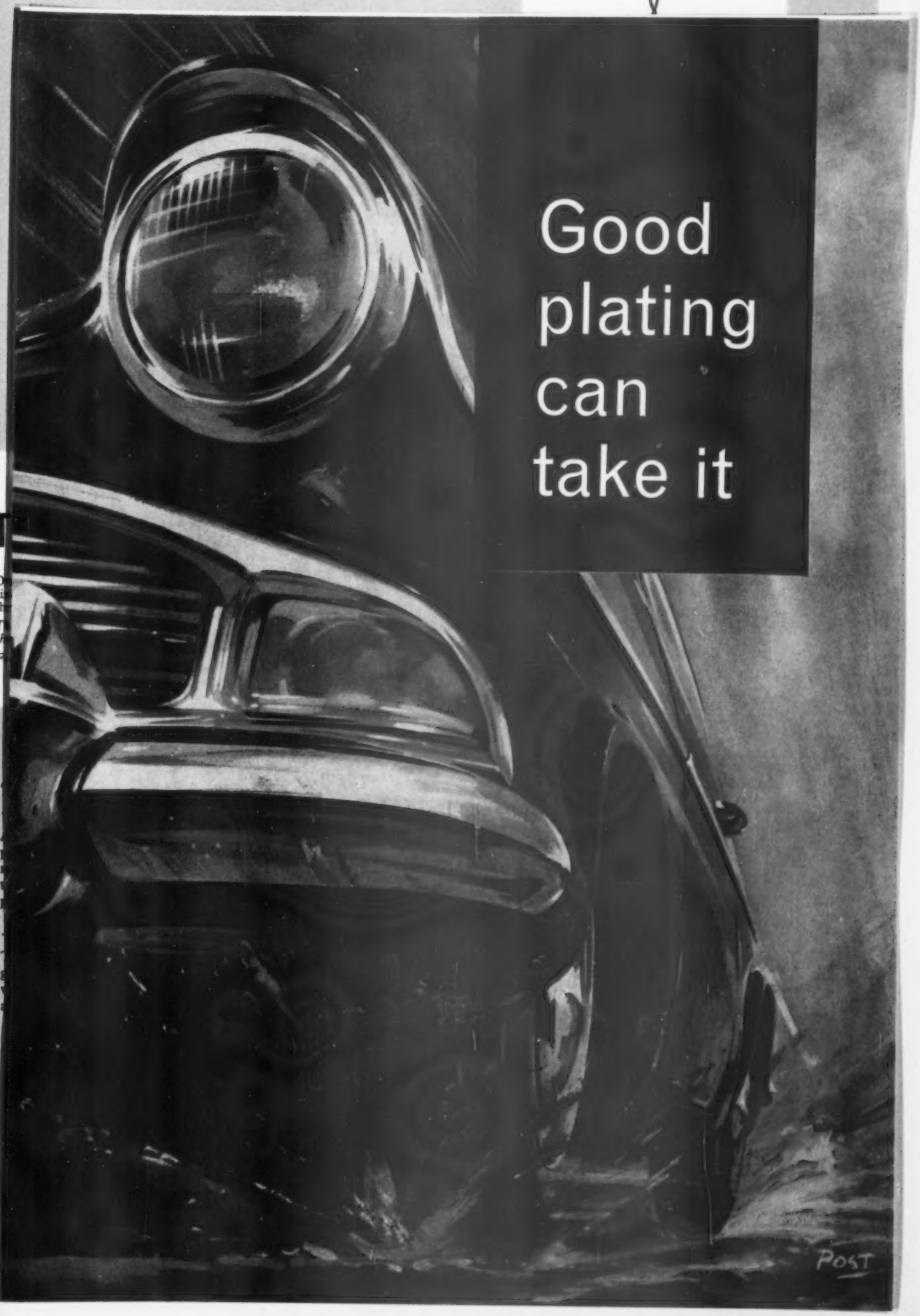
Good
plating
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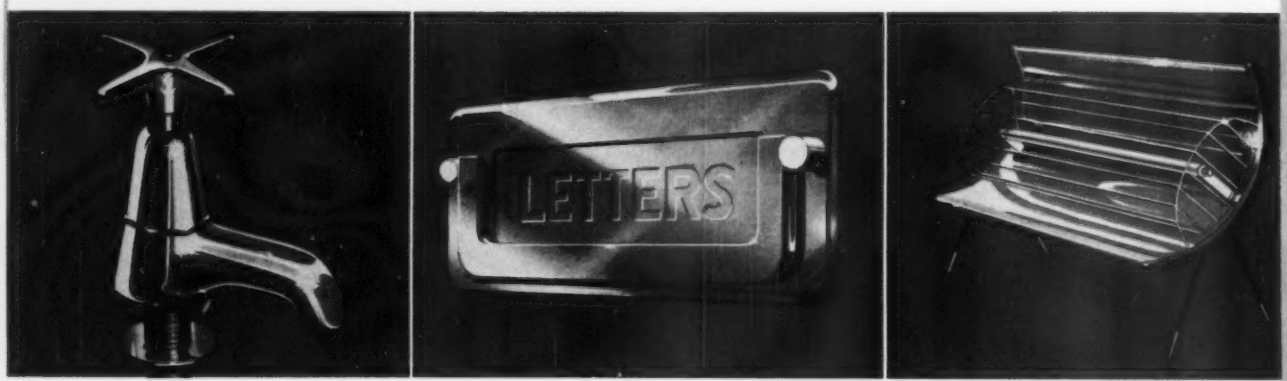
take it
POST

Good Plating means confidence and a bright sales future



On cars, household goods, door furniture, perambulators, bathroom fittings and many other products *chromium plating can be good!* With today's important advances in processing and control, it will keep its bright and lustrous finish, and withstand years of arduous service even in adverse weather conditions and corrosive atmospheres.
But the finest chromium plate must be backed by confidence. The public needs to be *told* that good chromium plate can give them years of shining service.

NICKEL *right* under chromium means better plating

What's behind good plating ? Manufacturers know already that the chromium must be of sufficient thickness, have satisfactory adhesion, and *must have sufficient nickel behind it.* The minimum thickness of both metals used depends on the service intended for the article, and is laid down in the new British Standard 1224 : 1959.
Unless these requirements are met, moisture or corrosive products may attack the basis metal. The result ? Complaints which waste time and harm reputations all down the line.

HOW MOND CAN HELP

The Mond Nickel Company is about to launch a unique campaign in the interests of better plating. Its aim is to spread new confidence in chromium plating and to encourage the public to buy the best and to look for the special "quality labels" on plated goods. Its success depends on the whole-hearted co-operation of platers and manufacturers of plated products—*you must join this important scheme.*

How you can benefit

If you are a plater or a manufacturer, you can benefit your business by taking part in this new campaign. You can also increase the reputation of plating as a whole. It simply involves affixing the necessary "quality labels" to those of your products which pass the appropriate grade of the British Standard. You will not be involved in any cost whatever, except a purely nominal charge for supplies of the labels.

The scheme is adaptable to the special problems of any trade; for example, on motor cars it may be preferable to include a leaflet in the instruction manual.

This label IS THE MARK OF GOOD PLATING

On the right we reproduce one of the labels which will be available in various sizes and in both tie-on and stick-on types. Three colours of label will denote the three grades of service conditions, laid down in the British Standard.

The labels will be supplied at cost, but conditionally on your undertaking to affix them only to goods which comply with the British Standard.

Free blocks are available to feature the labels in your promotion and advertising.

Red denotes a chromium plate to the "severe service" grade of B.S. 1224: 59 corresponding to exposure to weather and urban atmospheres.
Blue denotes the "moderate service" grading of the British Standard corresponding to conditions such as are found in kitchen or bathroom or in sheltered or rural atmospheres outdoors.
Green is for the "mild service" grading of the British Standard, i.e. use in warm, dry places mostly in the home.

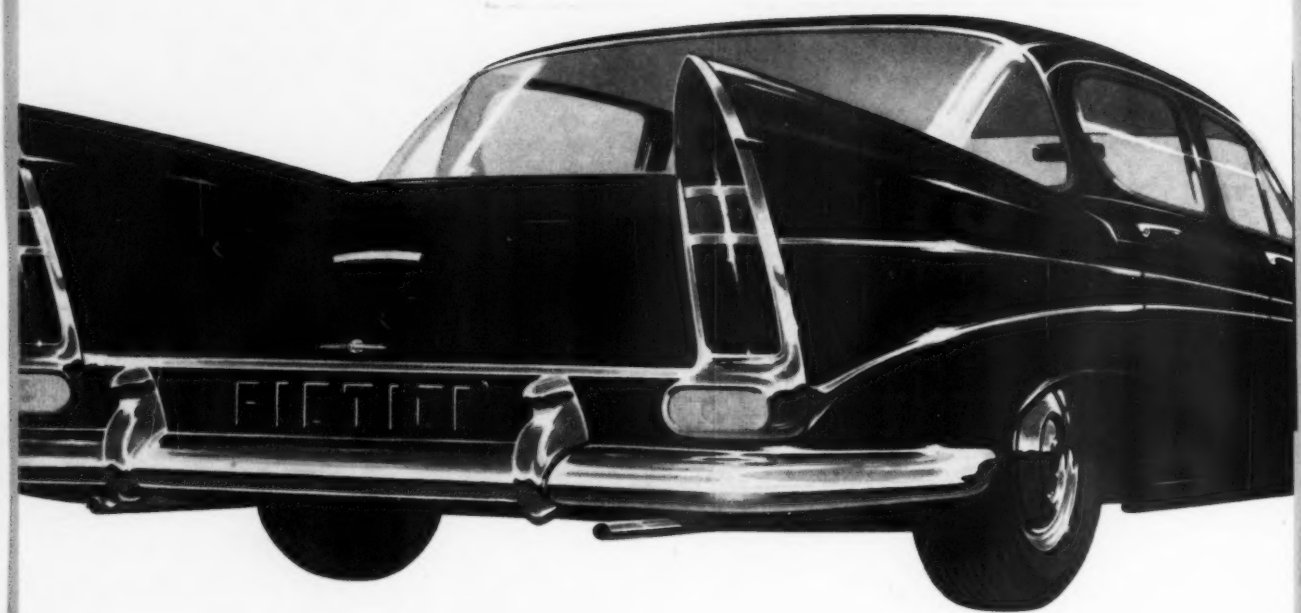
'LOOK FOR THE LABEL' — IN THE PRESS

A powerful and sustained Press campaign will encourage more and more members of the public to 'Look for the Label' before they buy chromium plated goods.

— ON TELEVISION

The story of 'Look for the Label' as a guarantee of good chromium plating will be told in frequent television spots at appropriate times of the year.

✳ Good plating means good business



MAKE SURE IT MEANS GOOD BUSINESS FOR YOU

Platers and manufacturers are invited to get in touch with The Mond Nickel Company Limited to discuss this new campaign. For further details, simply complete and return the card enclosed in this leaflet, or write to :

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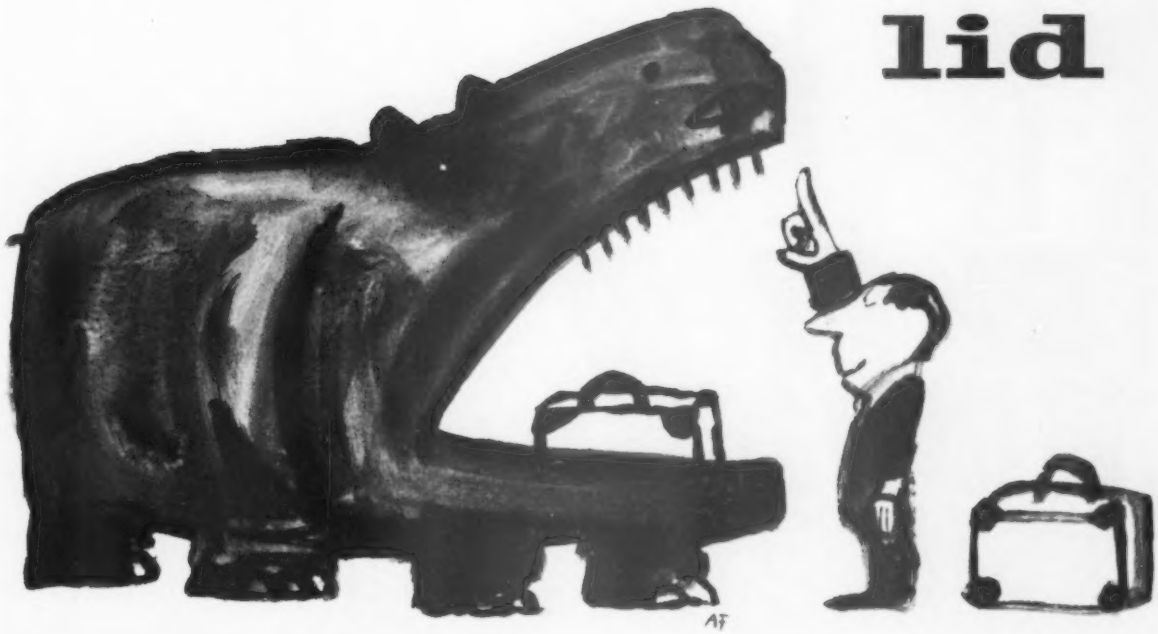
1818

You lift lid



Bonnet lid, or boot? Boot!
Inside see spanner, jack. Old newspaper, gardening glove lurking.
Dead match, dead mouse, dead resolution. Alas.

Nobody looking . . . lift lid again.
Click, whoosh. Why so light? Why so smooth firm easy?
Counterpoised. Contra-balanced. Cantilevered. Spring assisted.
When up, up. When down, down.
When only half-way up, neither one nor tother.
Wilmot Breeden research. Clever.

Boots, boots, boots, boots, movin' up an' down again.

Be serious. When up, up. Kick, shout, bang with clenched fist . . . Stays up.
Cardinal virtue. When downing simple routine.
Lift and lower (telescopic support).
Or press and lower (spring-loaded hingery).
All types. All Wilmot Breeden. Click!

Some day, clear out boot. Must. Burn paper. Bury mouse.
Meanwhile thank Wilmot Breeden smooth, light, easy, not chop fingers.
Boot-supports. Boot locks, too. Bumpers. Door locks, mechanisms.
Window winders. Wilmot Breeden. Radiator grill, maybe? May well be.
Good.

Virtually every British car roads today some Wilmot Breeden components.
Oh, good. (Mem: bury mouse.)

A limited number of booklets containing advertisements in this series is available.
Write to Advertising Dept., Wilmot Breeden, Oxford Street, Birmingham 5.

WILMOT BREEDEN are at Birmingham: *also at London, Manchester, Bridgwater, Glasgow, Melbourne, Toronto.*

. . . serving the Automotive industry

With the specialist knowledge of so many famous companies integrated within the concept and compass of the Birfield Group, it is hardly surprising that each newly announced automotive project inevitably features Birfield products in its specification. Propeller shafts by Hardy Spicer; Laycock de Normanville Overdrive; Salisbury Hypoid axles; connecting-rod and other forgings by Forgings and Presswork; Filters and Strainers by Intermit Ltd . . . . these are but a few of the automotive products of Birfield Group experience and resources which, separately or collectively, enhance the performance of almost every British car currently in production.

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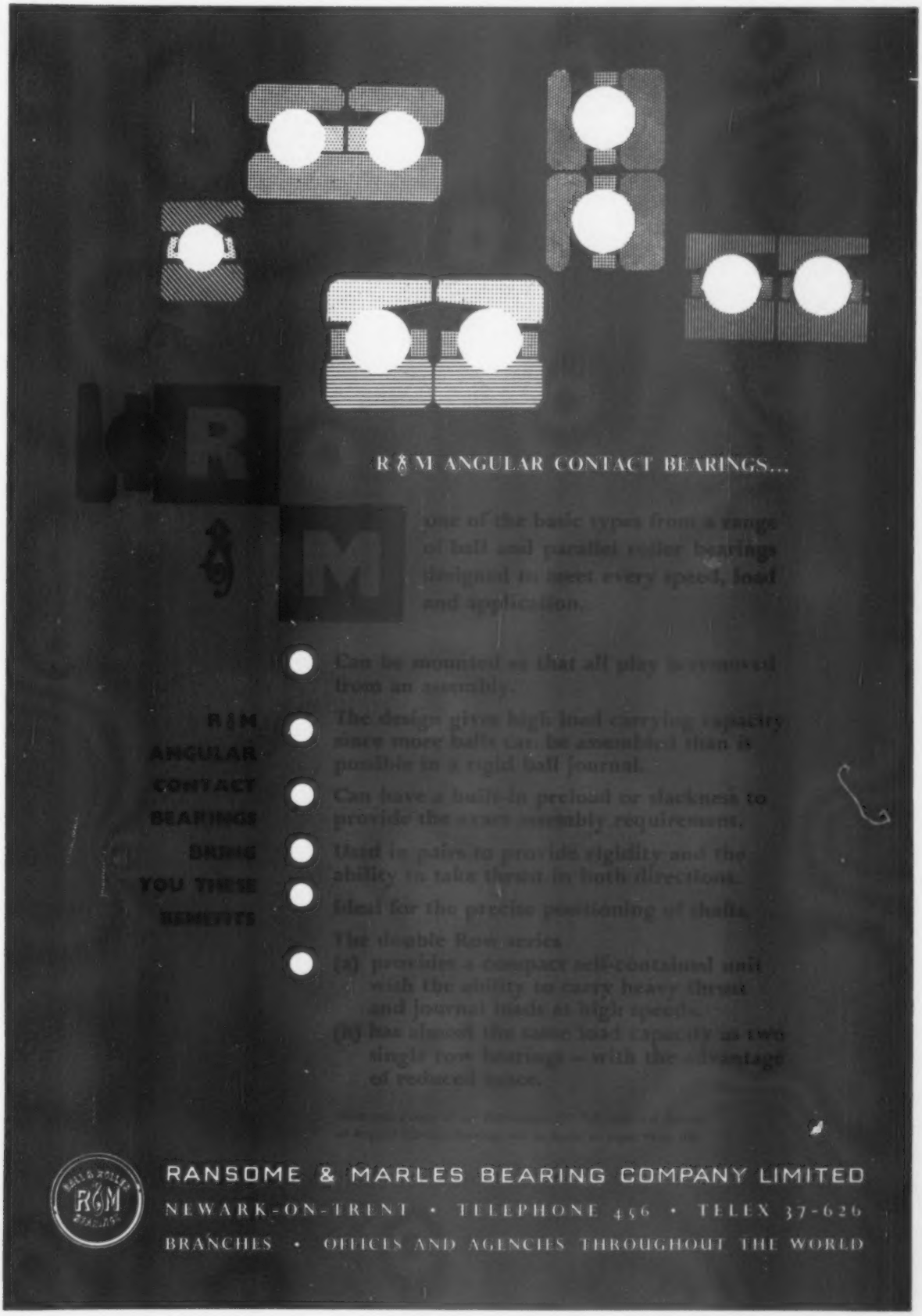
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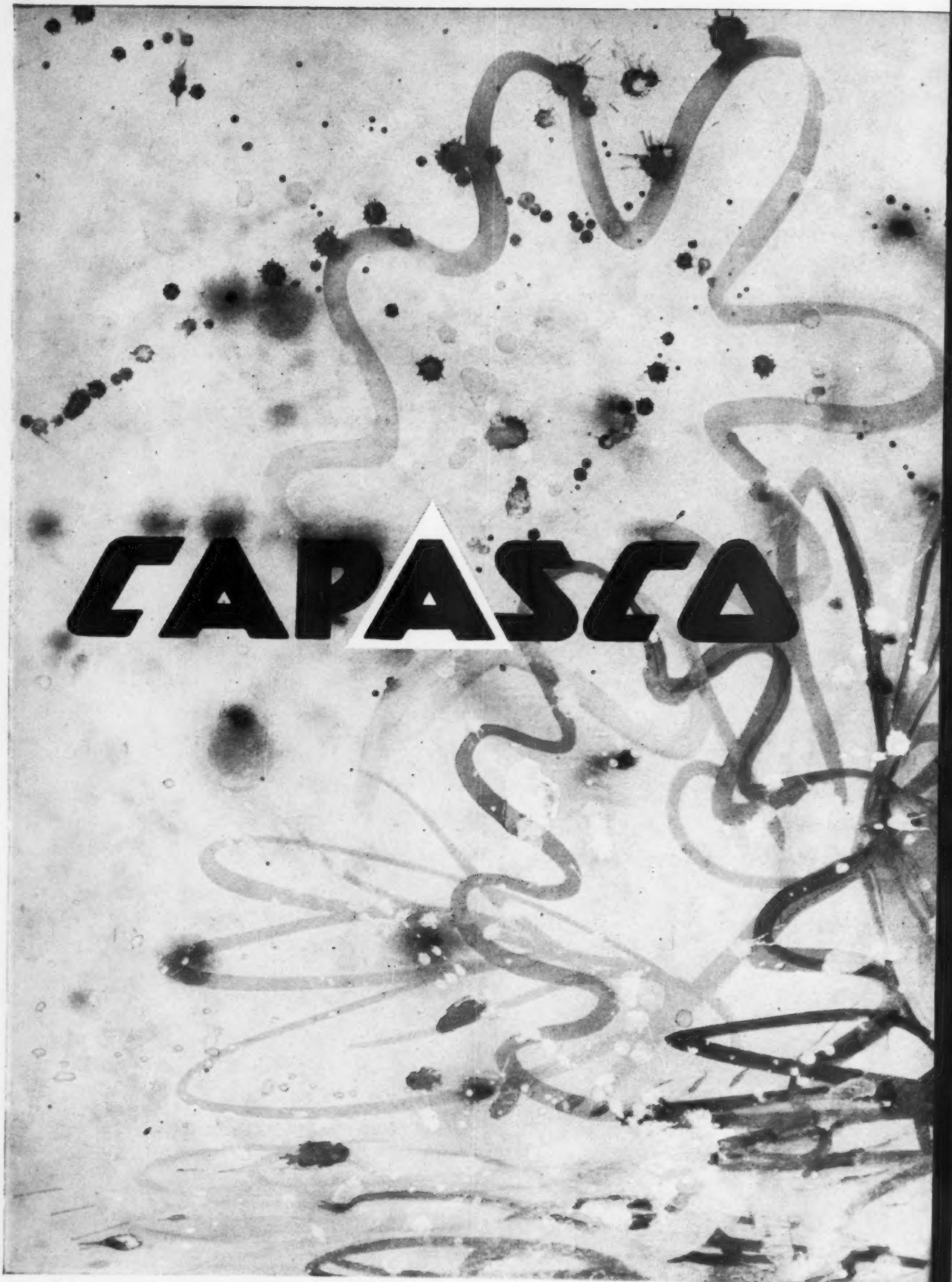
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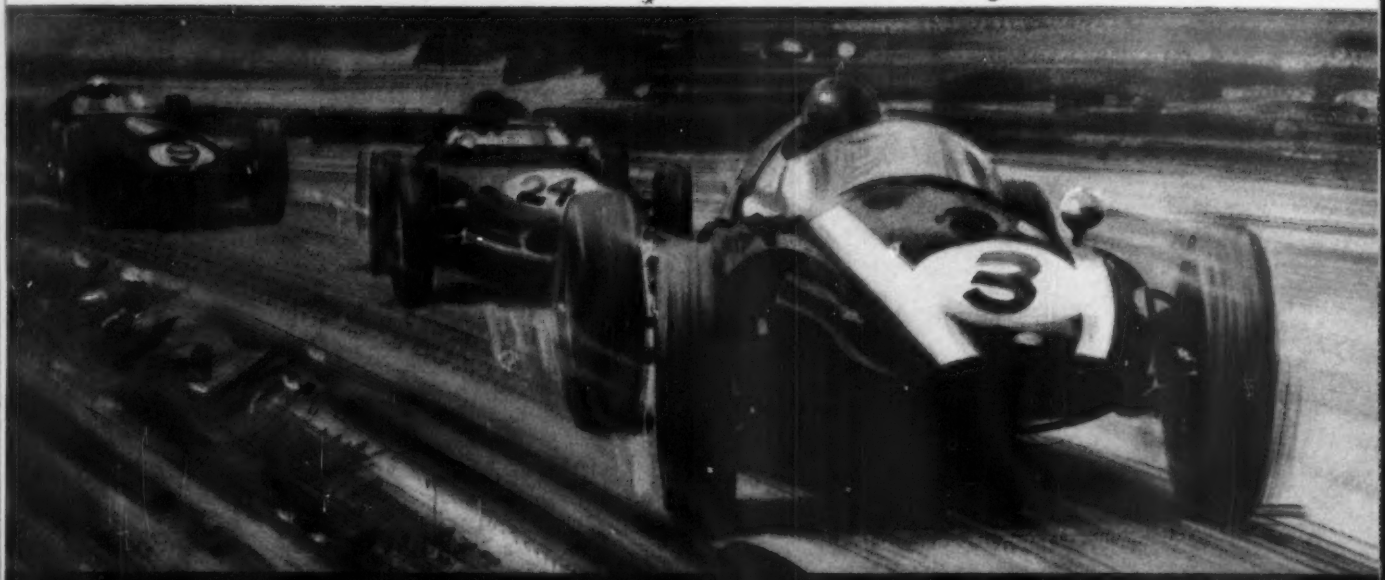

Major Events—January to August 1959

DATE	MEETING	RESULT
Jan. 10th	New Zealand Auckland Grand Prix	Cooper-Climax 1st, 2nd, 3rd.
Jan. 25th	Monte Carlo Rally : Charles Broum Trophy	Jaguar 3-car team.
	: Class Award over 2,000 cc.	Jaguar 1st & 2nd.
	: Coup des Dames	Austin A.40 1st.
	: R.A.C. Challenge Trophy	Austin A.40 1st.
	: Class Award up to 1,000 cc.	Austin A.40 2nd.
Feb. 7th	New Zealand. Teretonga Race	Cooper-Climax 1st & 3rd.
Feb. 8th	Canada: Winter Rally. Ladies Cup	Austin A.40.
Feb. 26th	Italy: Sestriere Rally: Touring Cars 500-1,000 cc.	Austin-Healey Sprite 1st.
	Touring cars over 1,600 cc.	Jaguar 3-4 1st.
Mar. 15th	France, Lyon-Charbonieres Rally: Ladies Cup	Austin A.40.
Mar. 21st	U.S.A. Sebring: Touring Cars Class 4	Austin-Healey Sprite 1st, 2nd & 3rd.
Mar. 30th	Ireland International Rally: Ladies Trophy	Morris Minor 1000.
Mar. 30th	Goodwood : Lavant Cup	Cooper-Climax 1st.
	: Sussex Trophy	Lister-Jaguar, 1st & 2nd.
	: Production Saloon Car Race	Jaguar 3-4 1st, 2nd & 3rd
Mar. 30th	Mallory Park : Sports Cars over 1,200 cc.	Lister-Jaguar 3-4, 1st.
	: Formula Libre	Lister-Jaguar 3-4, 1st.
Apr. 11th	Oulton Park : British Empire Trophy	Cooper-Climax, 2nd.
	: Sports cars over 1,500 cc.	Cooper-Monaco, 1st.
		Lotus-Climax, 3rd.
		Lister-Jaguar, 4th.
Apr. 18th	Aintree : Sports Cars over 1,100 cc.	Lotus-Climax 2nd.
		Lister-Jaguar, 3rd.
	: 2,000 cc. Class	Lotus-Climax, 1st.
		Cooper-Climax, 2nd.
	: Saloon Car Race	Jaguar 3-4, 1st, 2nd & 3rd.
	: Scratch Race Saloon Cars 1,600-2,600 cc.	Jaguar 2-4, 2nd.
Apr. 26th	Italy, Syracuse Grand Prix: Formula 2	Cooper-Climax 3rd.
May 2nd	Holland, Tulip Rally, General Classification	Jaguar 3-4, 1st.
	Class F: over 2,600 cc.	Jaguar 3-4, 1st & 2nd.
May 2nd	Silverstone: International Trophy, Formula 2	Cooper-Climax, 1st & 3rd.
	Sports Cars, 2,000-3,000 cc.	Lister-Jaguar, 3rd.
	Sports Cars, 2 litre	Cooper-Climax 1st.
	Sports Cars, 2 litre	Lotus-Climax, 2nd & 3rd.
	Production Touring Cars, General Class	Jaguar 3-4, 1st, 2nd & 3rd.
	Production Touring Cars, over 2,600 cc.	Jaguar 3-4, 1st, 2nd & 3rd.
	International Touring Cars, 1,300-1,600 cc.	M.G. 2nd.
May 10th	Monaco Grand Prix	Cooper-Climax, 1st & 5th.
May 16th	Pau Grand Prix: Formula 2	Cooper-Climax, 1st, 2nd & 4th.
May 24th	Targa Floria: 1,100 cc. Sports Class	Austin-Healey Sprite 2nd.
May 31st	Dutch Grand Prix	Cooper-Climax 2nd & 3rd.
		Lotus-Climax, 4th
July 5th	French Grand Prix, Rheims	Cooper-Climax 3rd.
July 18th	British Grand Prix, Aintree	Cooper-Climax, 1st & 3rd.
	Sports cars over 2 litres	Lister-Jaguar, 2nd, 3rd & 4th.
	Sports cars 1,400 cc. to 2 litres	Lotus-Climax, 1st & 3rd.
		Cooper-Climax 2nd.
Aug. 23rd	Portuguese Grand Prix	Cooper-Climax 1st & 2nd.
	(Subject to official confirmation)	

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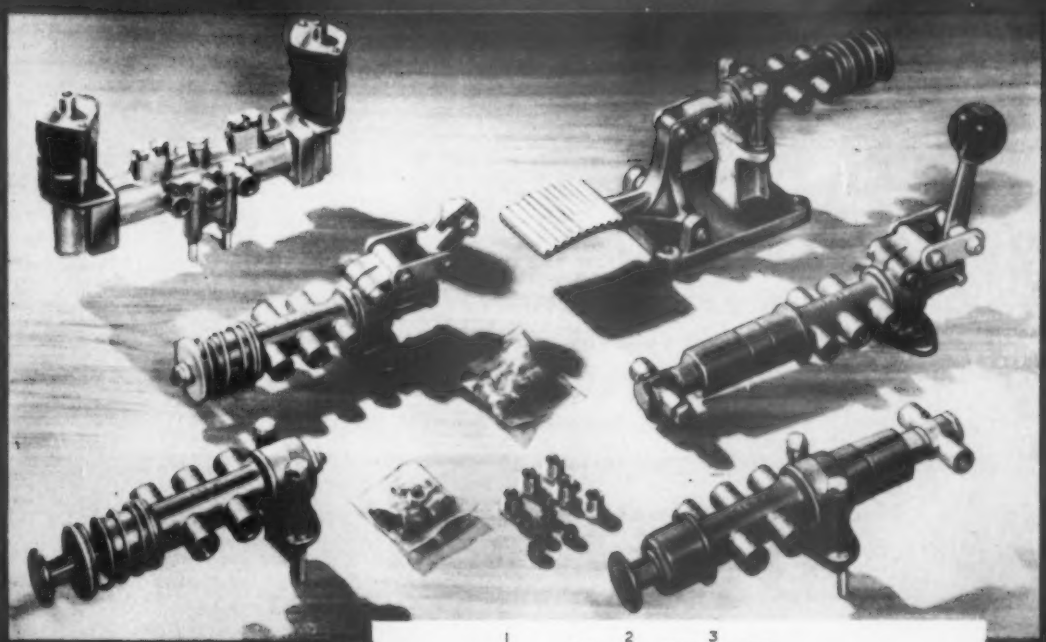

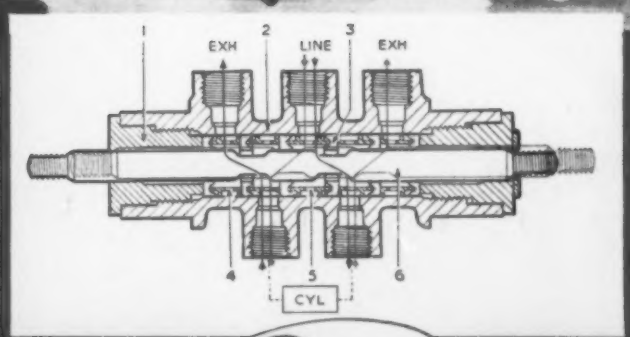

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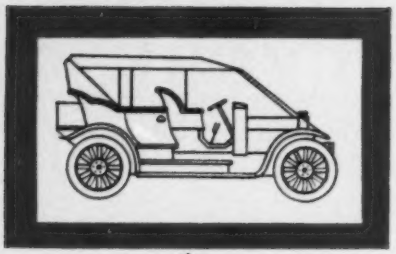

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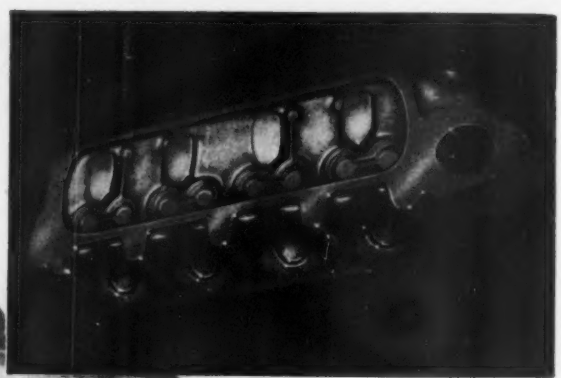

Cast iron cylinder head
for Austin A35 car.
By courtesy of Austin Motor Co Ltd.

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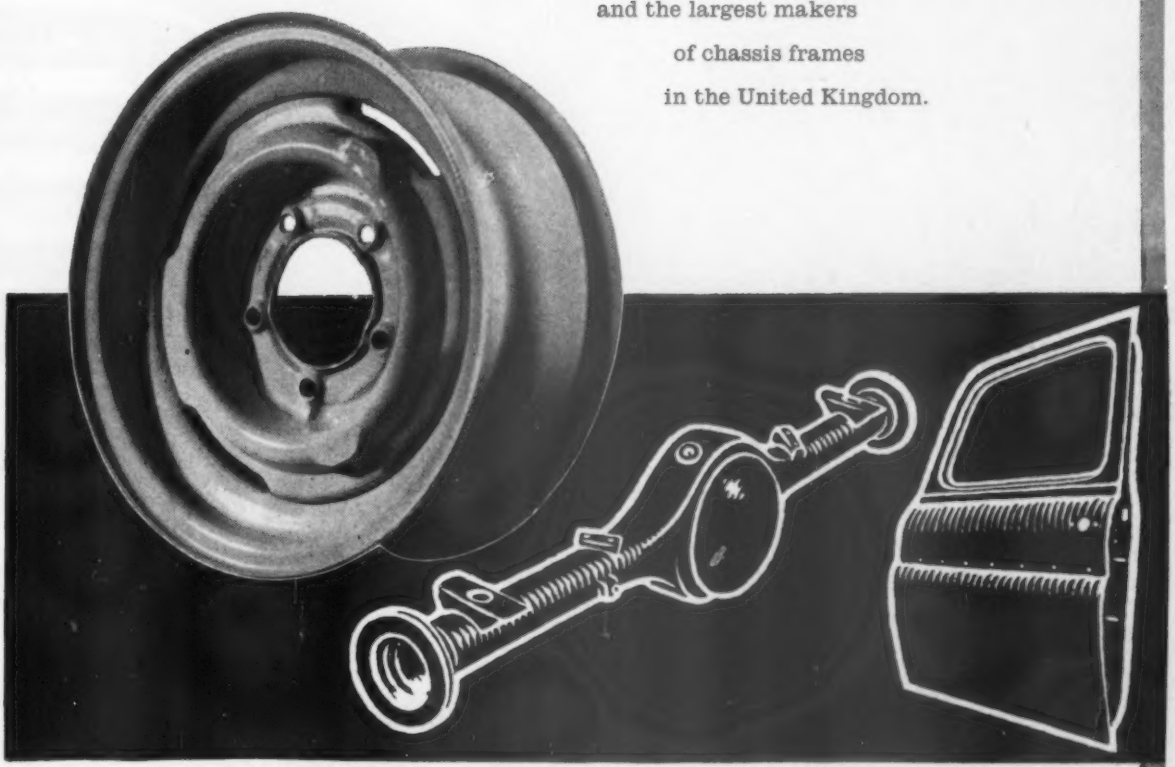

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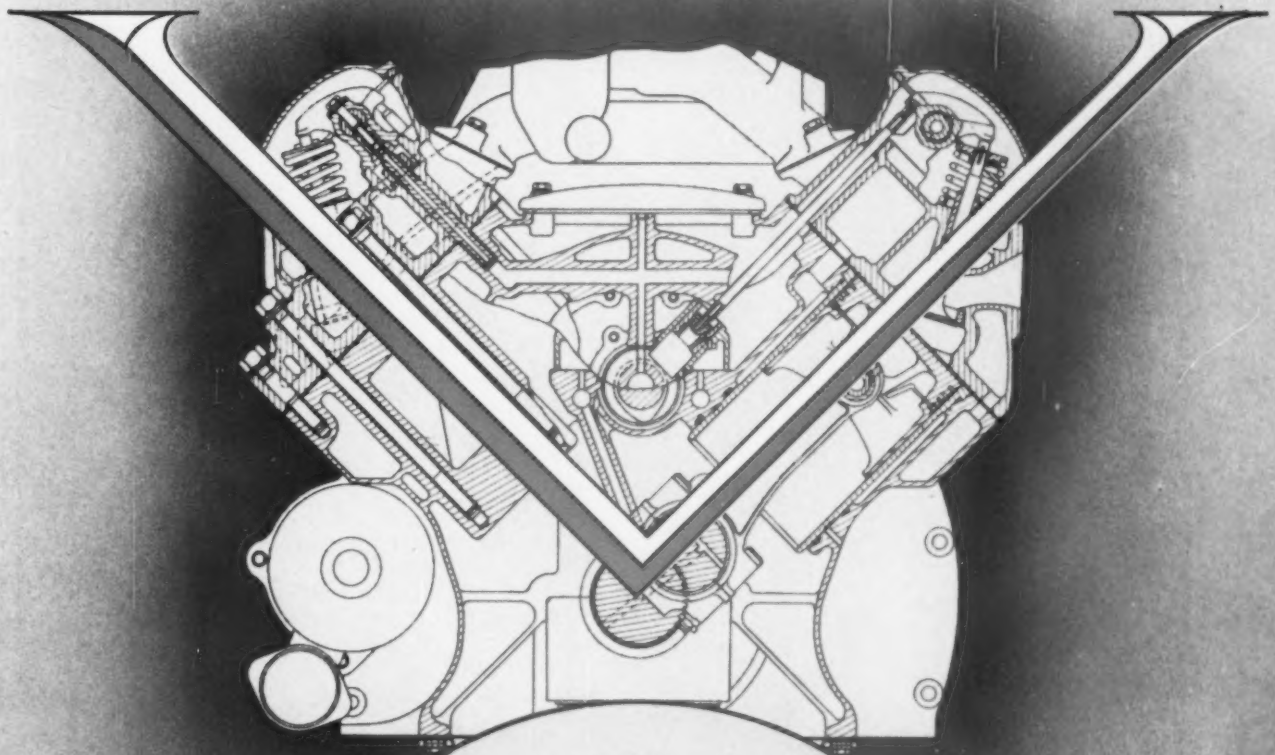

The characteristic smoothness of the new eight cylinder

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Here's a typical example of how the mechanical strength of Beetle D.M.C. (Dough Moulding Compound) helps to solve industrial problems.

These ear defenders are used to protect the hearing of workers in proximity to jet engines and in noisy factories. During the development work by the makers, Dennis Ferranti Meters Ltd., twelve sets moulded from conventional materials were delivered to Bomber Command for testing. The report of The Central Medical Establishment, Acoustics Laboratory, was that the ear defenders gave excellent protection, but that the mouldings then used were considered too fragile.

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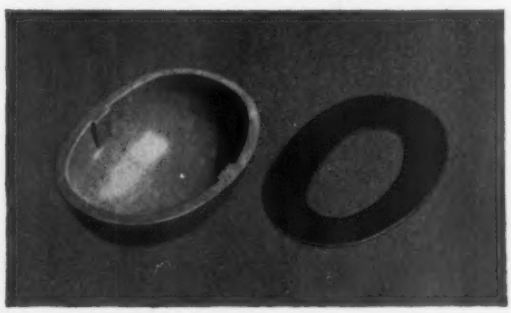
D.M.C. is the ideal material whenever high mechanical and/or electrical strength is required. The material can be moulded in conventional compression presses on short cure times and at low pressure. We shall be glad to send full technical details.



This illustration shows the main moulding from Beetle D.M.C. and a retaining piece made from Scarab material. The Earguards are used in engine testing, rivetting, blasting, rolling mills, weaving sheds, paper mills and on aerodromes.

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The EUCLID Earth Mover

The illustration shows one of the Euclid machines —the rear dump model F.D., made by Euclid (Gt. Britain) Ltd., Newhouse, Lanarkshire, Scotland. The particular model shown is designed for hauling large fragmented rock. The ruggedness of this machine will be understood by the fact that the pay load is 30,000 lb. and the engine is a 170 or 200 h.p. diesel engine. Further, the machine is, of course, intended to give a long life under tough hauling conditions off the highway.

The line drawings at the side show some of the details.

British Timken, Duston, Northampton, Division of The Timken Roller Bearing Company. Timken bearings manufactured in England, Australia, Canada, France and U.S.A.

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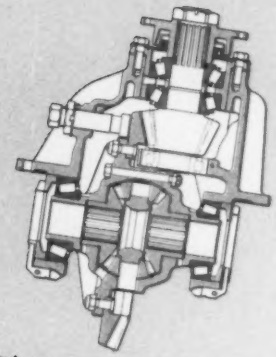
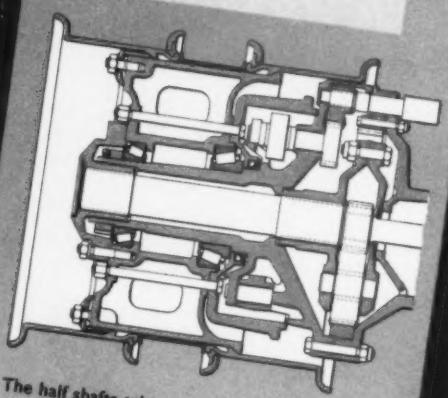
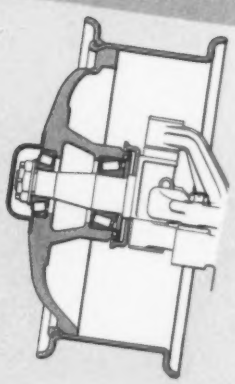


In the final drive unit shown above (made by E.N.V. Engineering Co. Ltd.) the spiral bevel pinion is mounted on two heavy-duty Timken bearings 2⅛" bore, locating the pinion in both directions, with a roller bearing on the nose piece of the pinion. This gives an extremely rigid straddle mounting. The differential carrier is carried in Timken bearings adjusted in a conventional manner.



The half shafts taking the drive from the differential sun wheels have pinions which engage with planetary gearing giving a further reduction at the wheels. The sun pinion floats without bearing support, being self-centred by the three planet wheels when under torque. The drive is then taken from the planet carrier to the wheels, which have a full-floating mounting on Timken bearings, of 6" and 5¼" bore, on the axle casing.



This shows the front wheel mounting on Timken tapered roller bearings of 2⅞" and 2¼" bore.

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for the Rear Axle of the

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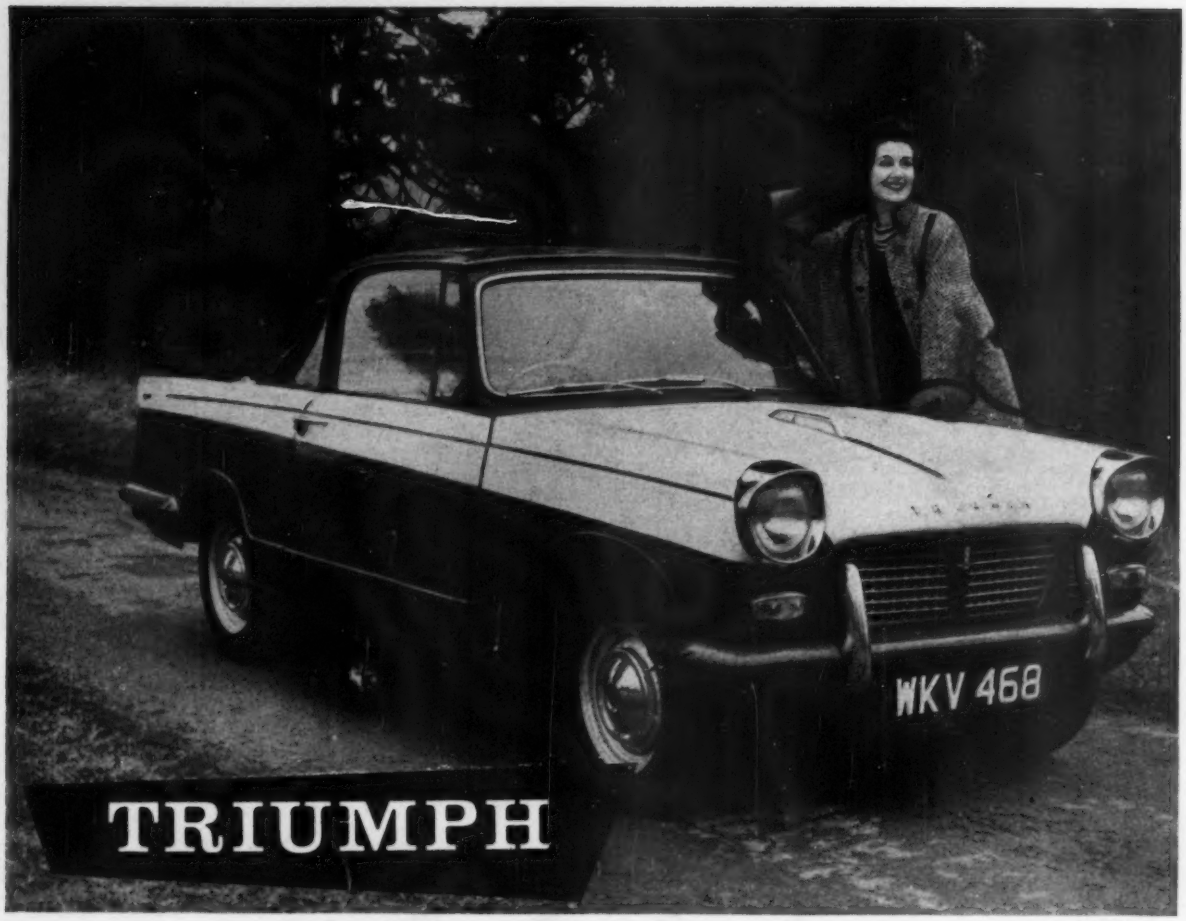
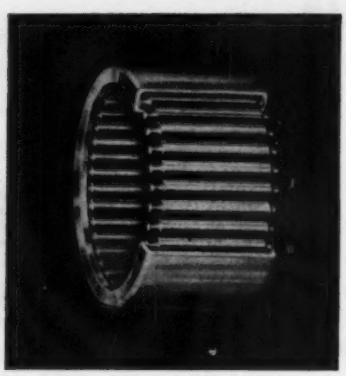


B59/E

with TORRINGTON



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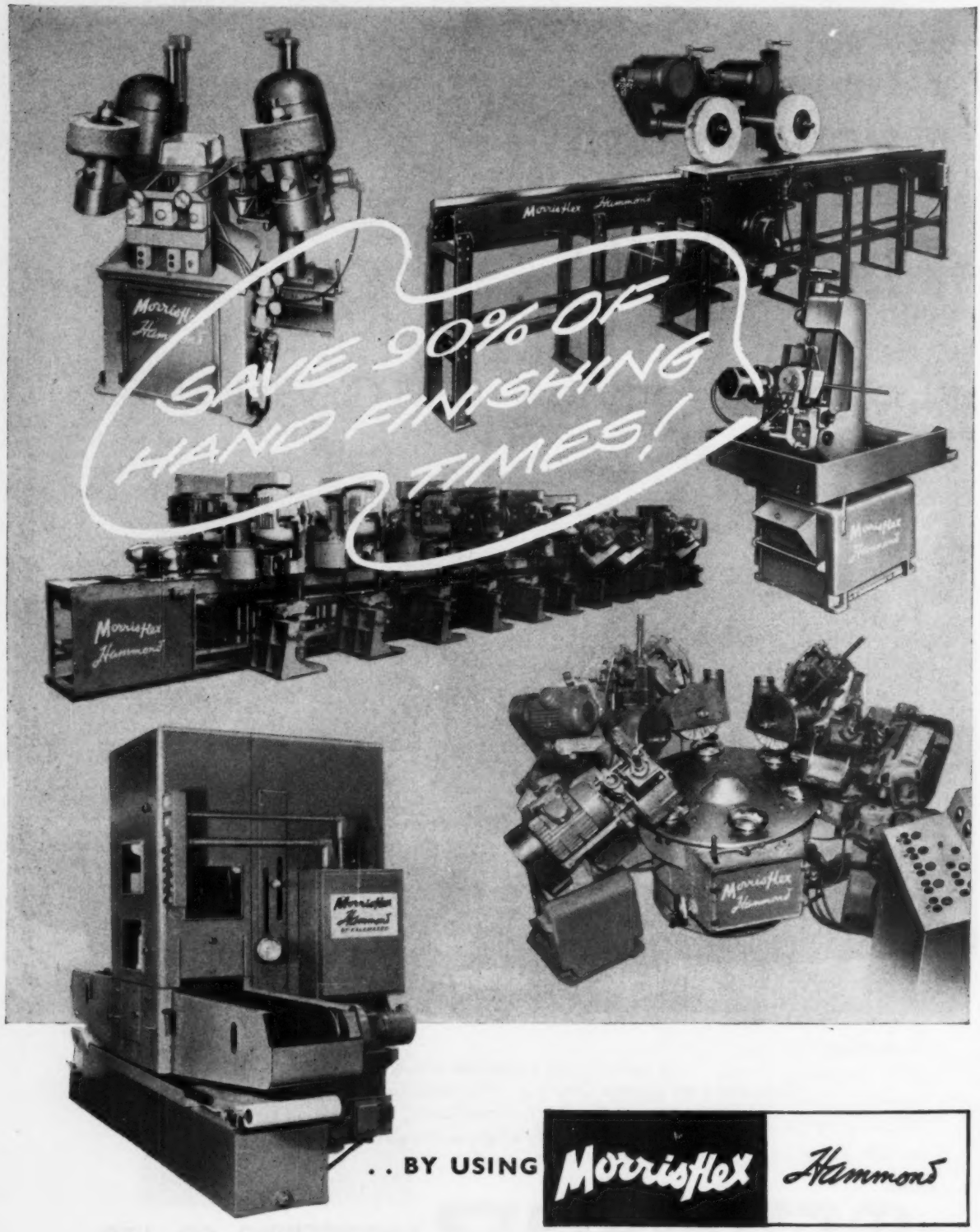

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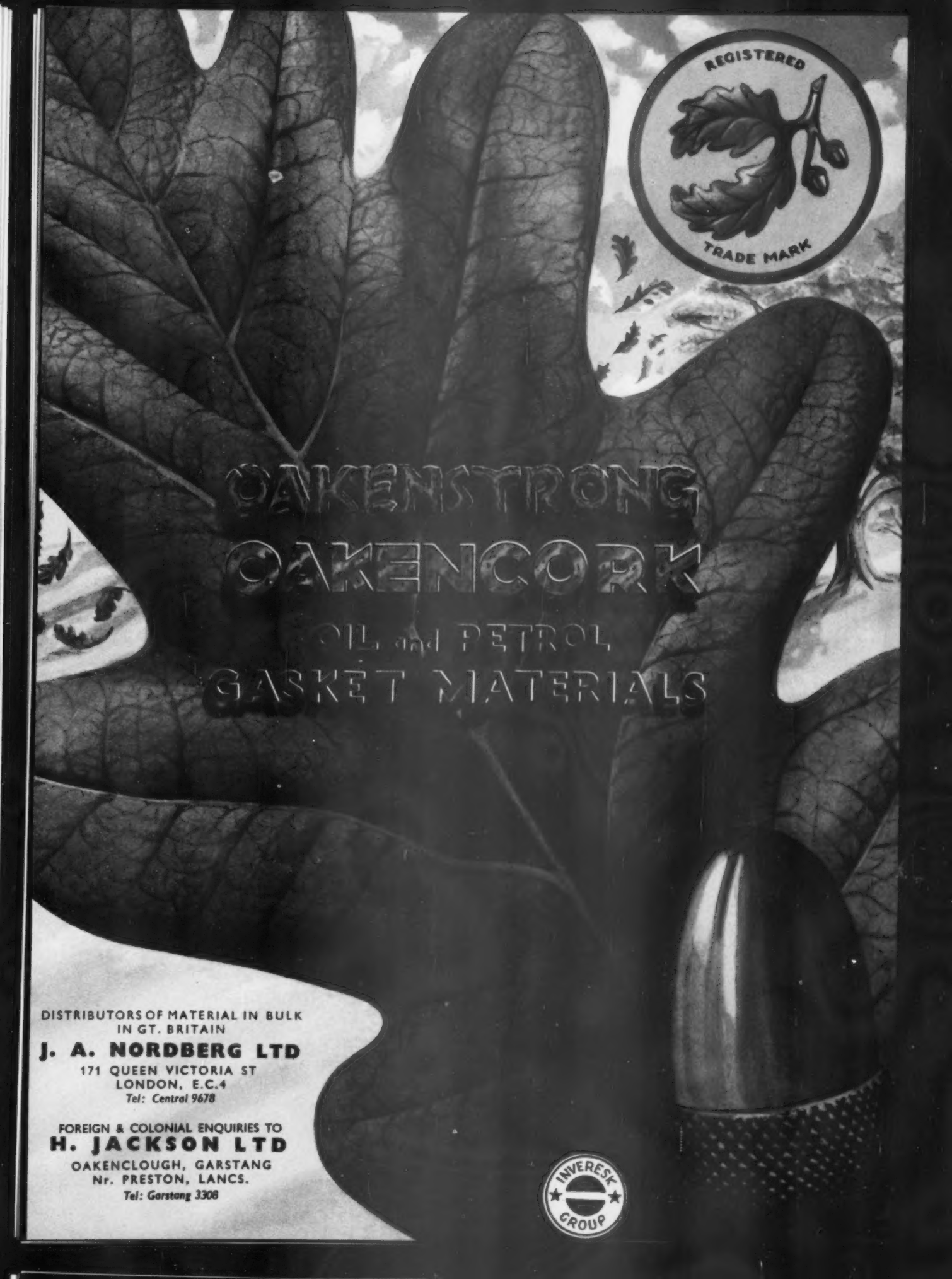

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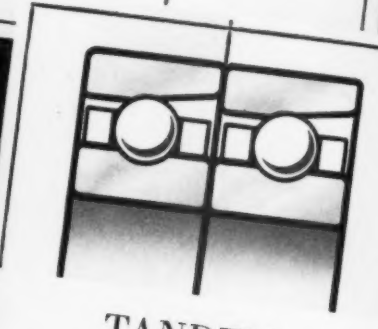

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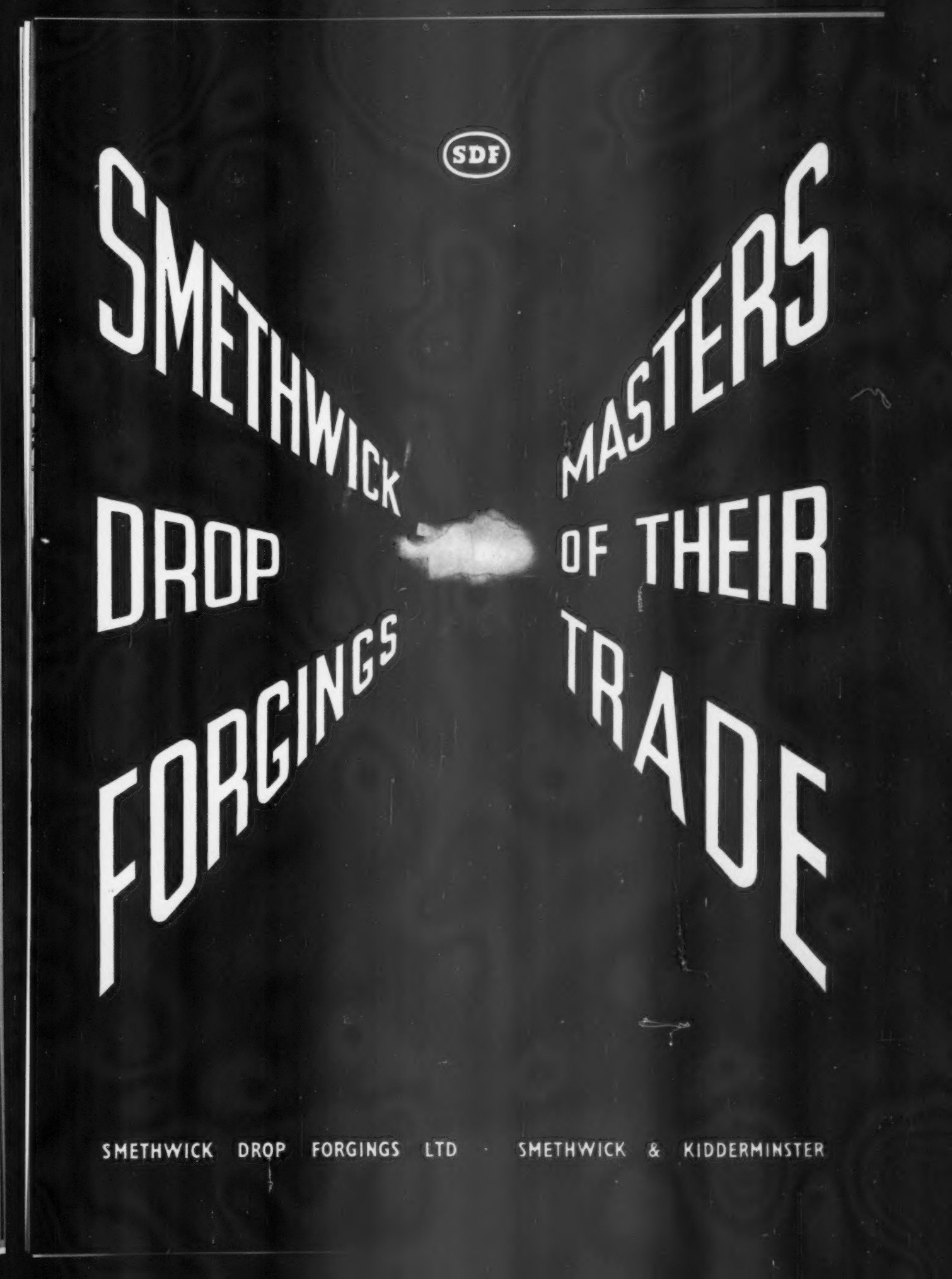
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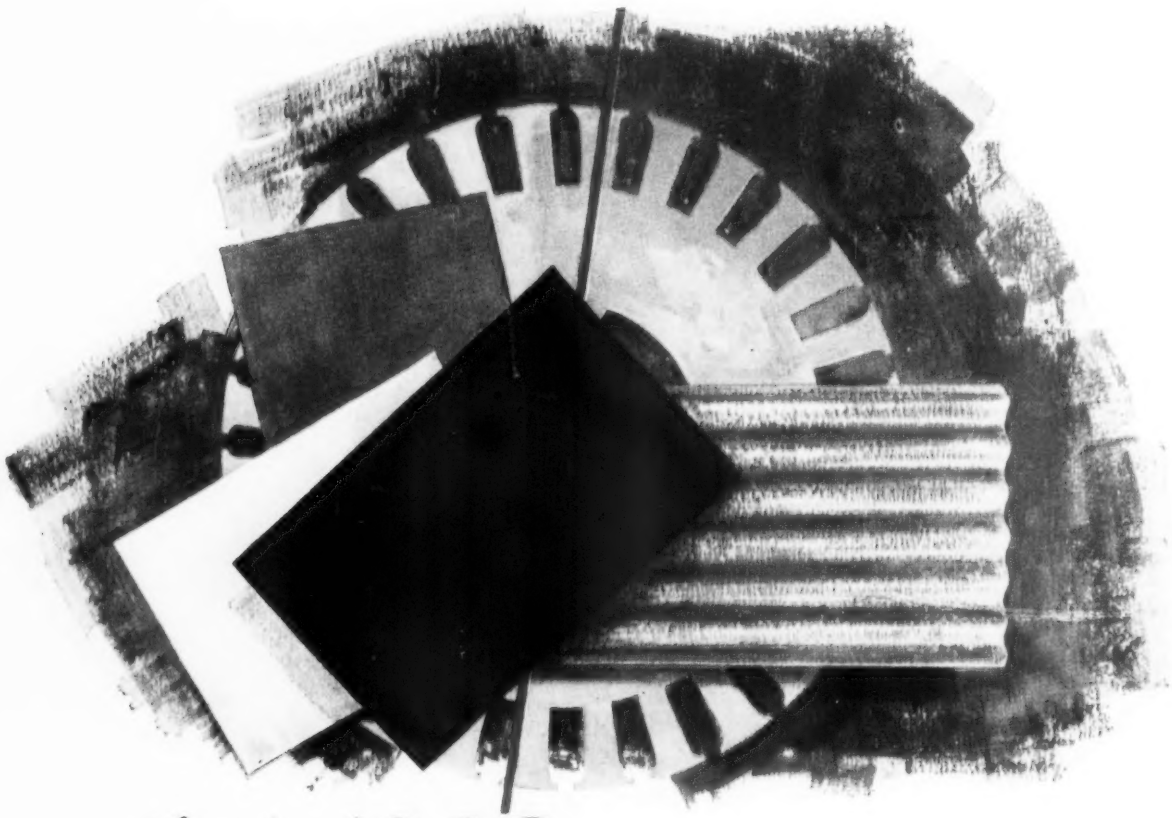

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AUTOMOBILE ENGINEER

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Published the second Wednesday in every month by ILIFFE & SONS LIMITED
*Dorset House, Stamford Street, London, S.E.*1
Telephone · Waterloo 3333 (60 *lines*)
Telegrams · Sliderule, Sedist London
*The annual subscription inland and overseas is £*3 0*s* 0*d including the special number*
Canada and U.S.A. $8.50

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DESIGN MATERIALS **AUTOMOBILE ENGINEER** PRODUCTION METHODS WORKS EQUIPMENT

Pointers for the Future

As usual there were many lessons to be learned from the Show. The adoption of an air cooled engine with horizontally opposed cylinders for what is, in European eyes, a relatively large car, is perhaps surprising in view of the inherent noisiness of this type of unit. Admittedly, it is less complex than would be a water cooled engine of this layout, and if aluminium cylinders are to be employed later, there will, of course, be no serious problems with regard to electrolytic corrosion.

An interesting feature among the British exhibits is the excessive over square cylinder dimensions of the Ford Anglia engine. By virtue of a short cylinder block and crank throw, some saving in weight undoubtedly is achieved. However, the important advantages of this design are that there is ample scope for development to increase the power output, not only by increasing the bore, but also the stroke, and there certainly will be no limitations with regard to main and big-end bearing capacities. It should also be possible to machine cylinder blocks for this and larger engines on a common production line. There will be no practical limitation on valve size, but the lift of the valves and the gas flow past them are also important. It will be interesting to see how the combustion problems are solved if the compression ratio is increased much more.

In view of the impending development of engines for operation at higher r.p.m., it is gratifying to observe that clutch design is keeping pace with requirements. The single, disc type spring, or Belleville washer, has much to commend it for clutches. It operates effectively regardless of engine speed, whereas coil type springs tend to bow under centrifugal force, and the torque transmission capacity of the clutch is accordingly reduced.

Another interesting development in the transmission field is the production of splines by rolling. Not only is this more economical than machining, but also the grain flow characteristics obtained are much better. It is to be hoped that this method of production can be extended to the manufacture of gears. In view of the relatively high proportion of vehicles exported from Great Britain to countries where wheel spin on ice and other slippery surfaces is a serious problem, it can hardly be denied that the incorporation of a limited-slip differential, at least as an optional extra, should be given serious consideration.

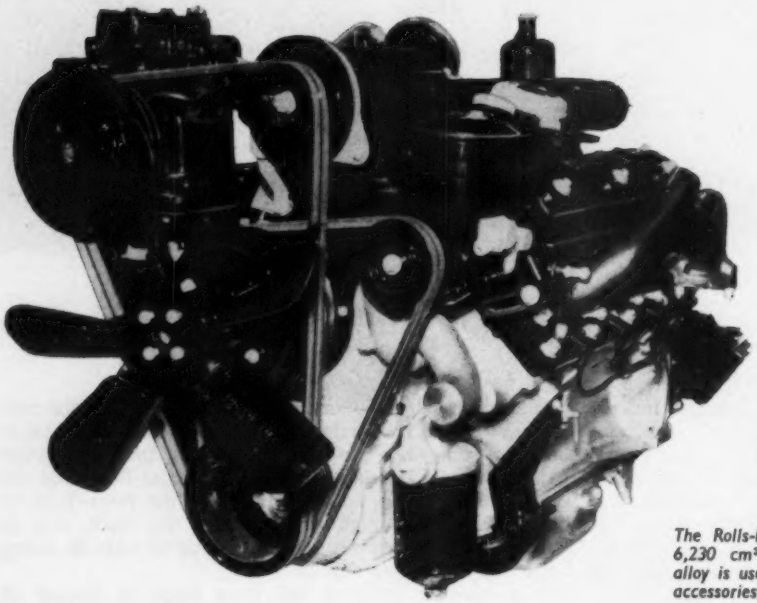
The adoption of a swing axle for the rear suspension of the Herald is perhaps surprising but, nevertheless, eminently successful. However, it should not be assumed that this type of suspension can be applied with equal success to any design of vehicle. The main requirements are a low centre of gravity and initial negative camber on the rear wheels. A low roll centre is, of course, difficult to achieve with a swing axle suspension, and the most successful solution so far devised is that of Mercedes-Benz. In the case of the Herald, an anti-roll bar at the front helps to compensate for a high roll centre at the back, and to counteract the oversteer tendency inherent with all swing axle rear suspension systems.

Considerable progress has been made in respect of suspension components. So far as springs are concerned, the rubber suspension arrangement used in the B.M.C. ADO 15 models is especially commendable. Because of its inherent instability, the rubber spring should be short and, therefore, the adoption of a 5 : 1 ratio of suspension motion : spring deflection is obviously the right solution to the problem. Nylon is being used increasingly as a dry bearing material but, because of its slight dimensional instability owing to its water absorption characteristic, it presents many design problems. Perhaps the best application for this material is in ball joints, where wear and dimensional tolerances are readily catered for automatically. Hydraulic dampers that can be adjusted by means of a control on the dash are now being introduced, and their advantages are so great that they are bound to become widely popular.

As is to be expected, disc brakes are becoming increasingly adopted, but their principal disadvantage relative to the drum type is the greater difficulty in respect of mechanical actuation of the hand brake. In general, the incorporation of a fluid level indicator for hydraulic reservoirs is to be encouraged. More attention should be applied to other safety devices, in particular to the design of systems in such a manner that failure of one part of the hydraulic system does not necessarily render the foot brake completely inoperative.

A useful development is the introduction of a sealed beam headlamp unit by Joseph Lucas. By virtue of the accuracy with which this type of unit can be focussed during manufacture, the setting of the headlamps can be a simple mechanical operation instead of requiring special optical equipment. Another advantage is that deterioration owing to blackening of the glass will be greatly reduced relative to that of the arrangement hitherto used, with conventional small bulbs. Another noteworthy advance is the adoption of an alternator as standard equipment on the Chrysler Valiant. The ability of an alternator to give a high output at low speeds will greatly relieve the strain on the battery, especially when the vehicle is operating slowly with a large number of electrical accessories in use.

LONDON SHOW REVIEW



Engines

New British V-Eight Units, Two with Part-Spherical Combustion Chambers; Extended Use of Aluminium; Rising Power Outputs and Compression Ratios

The Rolls-Royce V-eight engine, with a swept volume of 6,230 cm³, is an outstanding British newcomer. Light alloy is used for the main castings. Four V-belts drive the accessories, including an air compressor for refrigeration

A STUDY of engine developments at the Earls Court Show revealed a general picture of painstaking evolution rather than revolutionary changes. Although evidence of considerable progress was to be found throughout the whole range of sizes, it would appear that in this country more attention has recently been paid to the engines of 1½ litres and over than to the smaller units. On the Continent, the reverse seems to be the case, though the very small type of engine, for bubble-cars, continues to lose ground to the 600 to 700 cm³ class. There were several completely new engines, including three British V-eights and those of the American compact cars.

Apart from their impressive appearance, the new British V-eight units have considerable technical merit. The 6¼-litre Rolls-Royce unit, with its aluminium castings, complex accessories and rather limited installed accessibility, is clearly a luxury engine in which efficiency is not regarded as all-important. On the other hand, the 2½-litre Daimler sports car engine is a relatively stark and markedly efficient mechanism, although flexibility of performance and quietness have certainly not been neglected. The larger, 4½-litre unit is of similar layout but its characteristics are such that it is more suitable for the large saloon that it powers.

Although there is not the same demand here for engines of large swept volume as there is across the Atlantic, there may well now be a resurgence of interest in the V-eight type. Although it is inherently more expensive to produce than an in-line six-cylinder unit of equal capacity, its overall proportions are such that it is better suited to current body styles and chassis layouts. The dual cross-over type of induction manifolding, pioneered by Pontiac before the war and now in general use, gives satisfactory distribution with two carburettors or a single, twin-choke carburettor. Finally, the compact crankcase and short cylinder blocks of the V-eight layout result in a power unit that is structurally stiff.

The problem of economy of space has been tackled with outstanding success in the design of the new Austin Seven and Morris Mini-Minor, by the adoption of a transversely mounted engine at the front, driving the front wheels. This arrangement results in excellent accessibility for routine servicing. However, vulnerability cannot be ignored, and the layout can result in more weight on the front wheels than some consider desirable. On these B.M.C. cars, the front: rear weight distribution of 57:43 with an average load is not too far from normal and, in any case, a reasonable degree of inherent under-steer is probably preferable to the over-steer of a rear-engine car.

In most respects, of course, cast iron is an excellent material for cylinder block and crankcase castings: it presents few manufacturing problems, is adequately rigid, and does not require cylinder liners, so the heat flow is unimpaired. For cylinder heads, too, it has certain advantages in respect of rigidity, simplicity and ease of production.

In spite of these merits, cast iron has the two major disadvantages of relatively high weight and lower thermal conductivity than aluminium. For cylinder heads, the good conductivity of aluminium permits higher compression ratios to be used. It is known that much work on aluminium die castings has been done in the U.S.A., as well as here, and it had been expected that the engines of the American compact cars might have light-alloy main castings. However, the problems involved were such that so far only one, the Chevrolet Corvair, is so equipped in respect of the crankcase and cylinder heads. In this instance, the car layout adopted would hardly have been practicable with an engine having iron castings, because its weight would have caused excessive over-steer. The Corvair crankcase is, in any case, better suited for die casting in aluminium than are those of its competitors: it is shorter, by virtue of the horizontally opposed six-cylinder layout, does not embody the cylinders,

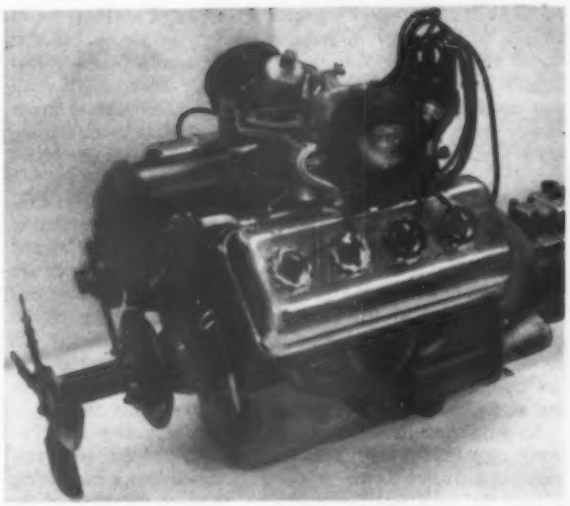
is open at top and bottom, and is split in the vertical, longitudinal plane.

In Great Britain, the only new production engine in which aluminium is used to the maximum extent is the Rolls-Royce V-eight unit, the aluminium crankcase-block unit of which is a triumph of foundry technique. An indication of what can be achieved is that the engine weighs no more than its six-cylinder forebear, although its swept volume is 27 per cent larger. Nevertheless, cost is not the prime consideration in the design of this engine, nor is it in that of the Coventry Climax racing units and the Aston Martin DB4 engine, all of which have light alloy main castings. All three firms have clearly appreciated that, as a structural material, aluminium has certain limitations in comparison with cast iron: its lower fatigue strength and Young's modulus demand that a greater bulk of material be used for a given duty.

For the present, at least, the Chevrolet Corvair engine has cast iron cylinders, possibly for structural reasons as well as to speed initial production. On the Rolls-Royce unit, wet liners are specified. This arrangement gives good heat conduction and the maximum water space for a given distance between the cylinder axes, and it enables replacement to be effected easily. However, it presents problems with regard to sealing, and the possibility of cavitational erosion, which is by no means unknown on diesel engines. It may yet prove practicable, of course, for pistons to operate directly in aluminium bores, and though the alternative of a chromium plated aluminium cylinder might prove to be satisfactory in service, it is necessarily expensive.

There are signs that cast iron crankshafts are finding increased favour. In view of the Ford Motor Company's long experience in this field, it is hardly surprising that the new Anglia engine should have a cast iron shaft. Although the specification of the material has not been divulged, it is probably of the spheroidal graphite type. Such irons can give an ultimate tensile strength as high as 45 tons/in^2, but in this form they are relatively expensive and their elongation may be 8 per cent or even more.

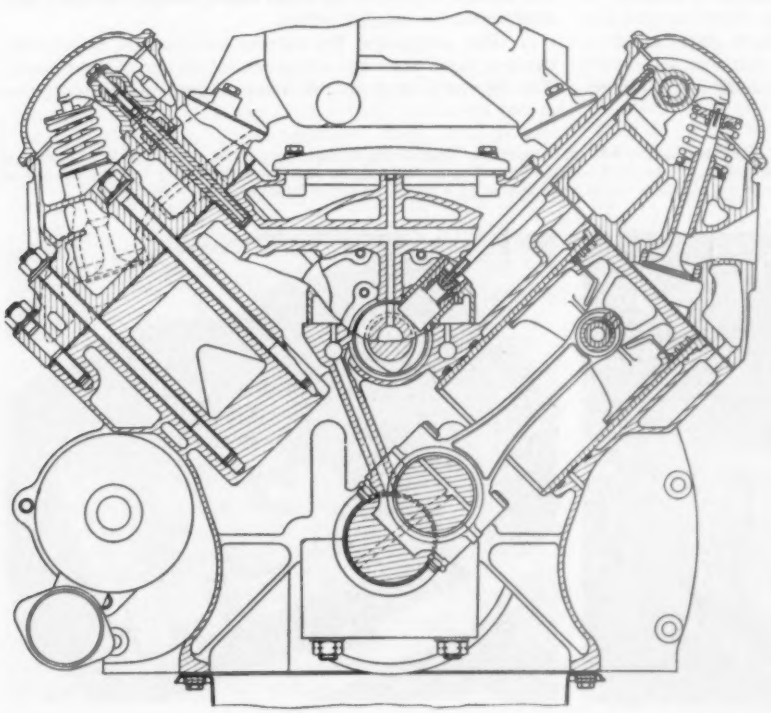
A good compromise may prove to be a lower-strength iron, in which the graphite is not fully converted to the nodular form. This material, which is used for crankshafts produced by Dartmouth Auto Castings Ltd., can have a strength in the region of 35 tons/in^2, an elongation of not more than 4 per cent, and its cost per shaft would be appreciably lower than that of the higher-strength iron. However, a shaft made of it would have to be specially designed with the lower strength in mind. Whatever the specification, cast iron is clearly better suited to short-throw than long-throw shafts. This is because of the journal overlap obtained with a short stroke, and the lower centrifugal stresses for a given rotational speed.



Another new V-eight is the Daimler 2,548 cm³ unit, developing 140 b.h.p. It has part-spherical combustion chambers; the valves are actuated by push rods and rockers, with separate shafts for inlet and exhaust rockers

There is a continued trend towards lower stroke: bore ratios. The Humber Super Snipe and B.M.C. Series C engines have both been enlarged from 2·6 to 3 litres by increasing the bore. On the other hand, the new Rover 100 engine is a short-stroke version of the 3-litre unit; similarly, the B.M.C. ADO 15 has a short stroke relative to the Series A engine.

At the present stage of engine development, it may be said that a stroke: bore ratio of about unity is a good compromise. Valves of of adequate size can be installed, even in a bath tub type combustion chamber of relatively high compression ratio; the mean piston speed is usually moderate, and the proportions of the engine are satisfactory from the installational viewpoint. On this basis, the Ford Anglia, with its ratio of just under 0·6:1, may seem to have



On the Rolls-Royce engine, overall width has been minimized by the employment of wedge type combustion chambers with a relatively large included angle. The latest version has toroidal depressions in the crowns of the four-ring pistons

an unnecessarily short stroke. However, the Ford technicians had to bear in mind the need for an engine that would sustain high cruising r.p.m., yet would permit a low bonnet line; the extra length of a very short-stroke unit was not regarded as critical. Certainly the engine is structurally rigid, and the relatively large connecting rod : stroke ratio would permit an increase in stroke without major changes, if a larger swept volume were wanted.

As stroke : bore ratios fall, it becomes increasingly difficult to maintain a satisfactorily compact combustion chamber. To extend the power curve by taking advantage of the higher rotational speeds possible, larger valves are necessary; but if, at the same time, benefit is to be gained from advances in fuel technology, by employing higher compression ratios, clearance volumes must be reduced. In evolving a chamber to meet these conflicting requirements, the designer has to consider not only the size of the valves but also their lift and the flow of gas past their heads.

Although the bath tub chamber, with vertical valves, has been remarkably highly developed during the past few years, any further advances in compression ratios may bring it near the limit of its possibilities, through masking of the valves. The wedge form of chamber has become the most popular in the U.S.A., and though it tends to have a higher surface : volume ratio than the bath tub type, it usually gives less masking in engines having high compression ratios. Also, because of the inclination of the valves, less curvature is necessary on both sets of ports, provided the inlet and exhaust manifolds are on the same side of the head, so that the breathing can be further improved. With manifolds on opposite sides, as on V-type engines, however, only the inlet ports can be straightened.

It is worthy of note that, of the new British V-eight engines, the Rolls-Royce unit has combustion chambers of wedge form, although the compression ratio is relatively low. Because breathing requirements were not critical, the valves are relatively small and therefore the wedge form is compact, with a large angle and a short upper face. The new aluminium cylinder head of the Sunbeam Alpine and Rapier engines, on which the compression ratio is 9·2 : 1, has a bath tub type chamber, but with the valves inclined at a small angle to the vertical. This change from the previous Rootes practice of vertical valves was made partly to effect a slight improvement in the breathing, but also to permit an increase in the size of the water passages in the region of the exhaust valves. A similar layout is employed on the engine of the Ford Falcon compact car which, in this respect, is not unlike the British Zephyr and Consul engines.

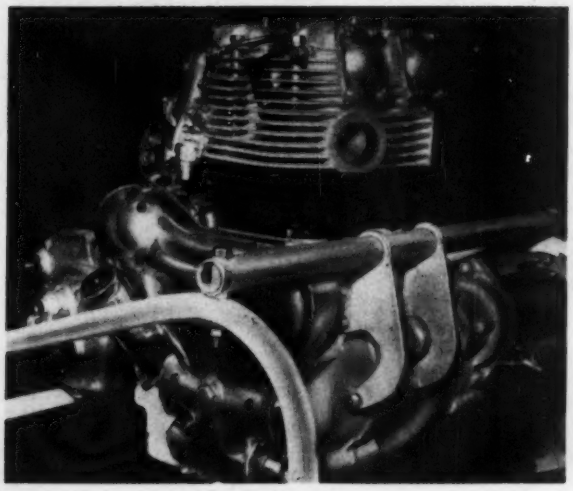
Unlike the Rolls-Royce V-eight engine, both the new Daimler units have part-spherical combustion chambers. The theoretical advantages of this layout are well known, and even with high compression ratios, a reasonably compact chamber form can be attained. On these Daimler engines, the valves are actuated by a single camshaft, push rods, and rockers on two shafts on each cylinder head. Although this chamber and valve arrangement is rather more costly than the bath tub layout, with a single rocker shaft, its technical merits could well result in its finding increasing favour on other than the cheapest engines. High efficiency is claimed for the unique, polyspherical chamber of the Fiat 1800 and 2100 engines, but this layout seems unnecessarily complicated and expensive to produce.

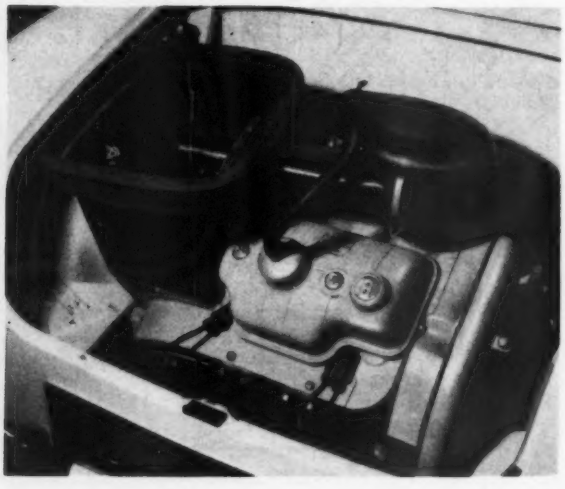
The part-spherical chamber can readily be fully machined, as also can the wedge chamber when used in conjunction with an inclined head joint face; because of the need to ensure equal clearance volumes in the various cylinders, this characteristic is becoming increasingly important as compression ratios rise. Fully machined chambers are, so far, relatively rare in quantity-produced British and European engines, but it is encouraging to find them on the new Ford Anglia unit. The resultant consistency in the octane requirement of all the cylinders, within the limits imposed by any distribution irregularity, has enabled the unusually high compression ratio of 8·9 : 1 to be used with a cast iron cylinder head.

It will not have gone unnoticed that the Rover Company, on its new 80 engine, has departed from its traditional post-war combustion chamber design of the so-called F head with an inclined joint face and side pockets at the top of the bores. With a long-stroke engine, this arrangement has the advantage of combining a compact chamber with adequate space for the valves, but as the stroke : bore ratio is reduced the problem of installing large enough valves obviously becomes less pronounced. Therefore, the new, over-square engine, developed from the Land-Rover unit, has the less expensive layout of kidney-shape chambers and nearly vertical, parallel valves.

A table comparing the current compression ratios with those of three years ago is reproduced on one of these pages. The figures quoted are the mean of the compression ratios

Two variations on the parallel-twin theme. Left: The Royal Enfield 692 cm³ engine now fitted to the Berkeley cars needs no cooling fan because of its frontal installation. Right: The rear mounted, 583 cm³ unit of the NSU Prinz 30 is cowled and fan cooled. Both engines have part-spherical combustion chambers: in the case of the NSU, the valves are actuated by a single, eccentric-driven overhead camshaft

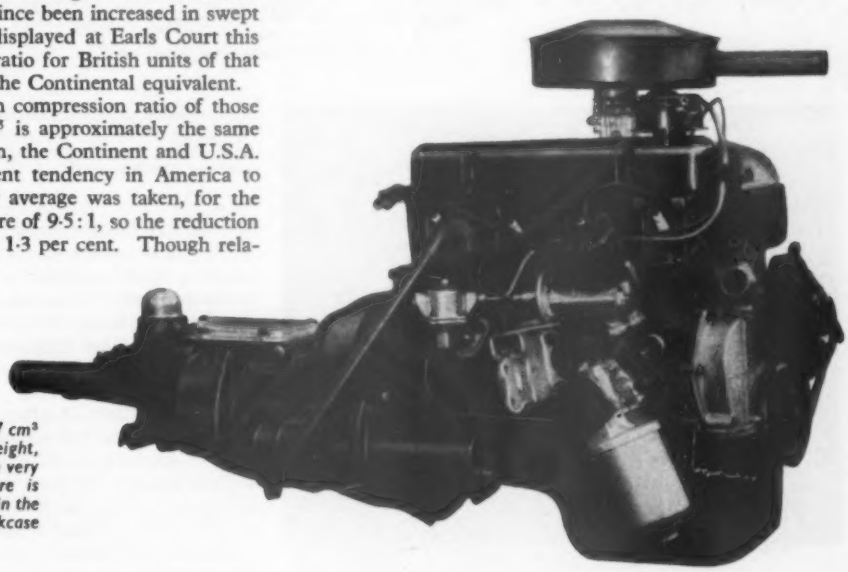




of all production cars for which the information was obtainable. This table reveals several interesting facts, the first of which is that in Britain the engine category subject to the most change is that between 1,000 and 1,500 cm³. The ratio increase of 12 per cent in three years is remarkably large. By comparison, the smaller engines have been neglected and, though in 1957 their average ratio was slightly higher than that of the second category, it is now considerably lower. Since it is, in general, possible to raise the ratio as the cylinder size is reduced, there is clearly scope for further development on those engines of less than 1 litre swept volume.

In direct contrast to the situation in this country, on the Continent it is on the smaller engines that the biggest advance is shown, whereas the increase of ratio within the second size-group is small. The only class in which the figure for 1957 was higher than that for British engines is the third in the table. This Continental average included several sports cars; some of these have since been increased in swept volume while others were not displayed at Earls Court this year. As a result, the average ratio for British units of that size has now overtaken that of the Continental equivalent.

It will be seen that the rise in compression ratio of those engines of more than 2,000 cm³ is approximately the same in all three areas—Great Britain, the Continent and U.S.A. However, in view of the present tendency in America to reduce ratios slightly, a further average was taken, for the 1959 engines. This gave a figure of 9·5:1, so the reduction during the past year amounts to 1·3 per cent. Though relatively small, the reduction is sufficient to indicate that some American designs were too advanced relative to the present stage of engine and fuel technology. Apart from possible trouble with exhaust valves and sparking plugs, with ultra-high compression ratios, the phenomenon known as combustion rumble is known to have proved intractable in some instances. Also, the extra performance obtained was virtually unusable and the small gain in thermal efficiency was more than offset by the higher cost of super grade fuels. The ratios on the new American smaller engines are more in line with British and Continental practice.



This view of the new Ford 105E, 997 cm³ Anglia engine shows the low overall height, which results from the adoption of the very short stroke, of 48·41 mm; the bore is 80·96 mm. The oil pump is embodied in the filter housing mounted on the crankcase

The continued trend away from siamesed inlet ports is worthy of mention. Apart from the less good flow characteristics of siamesed ports, in comparison with individual ports, a certain amount of inter-port robbing of the charge is almost inevitable. One of the engines on which a change to individual inlet ports has been made this year is the Alvis 3-litre. An allied trend, exemplified by Vauxhall and certain Rootes units, is to arrange the valve sequence so that no two exhaust valves are adjacent, thereby minimizing heat concentration and the consequent risk of distortion or combustion troubles.

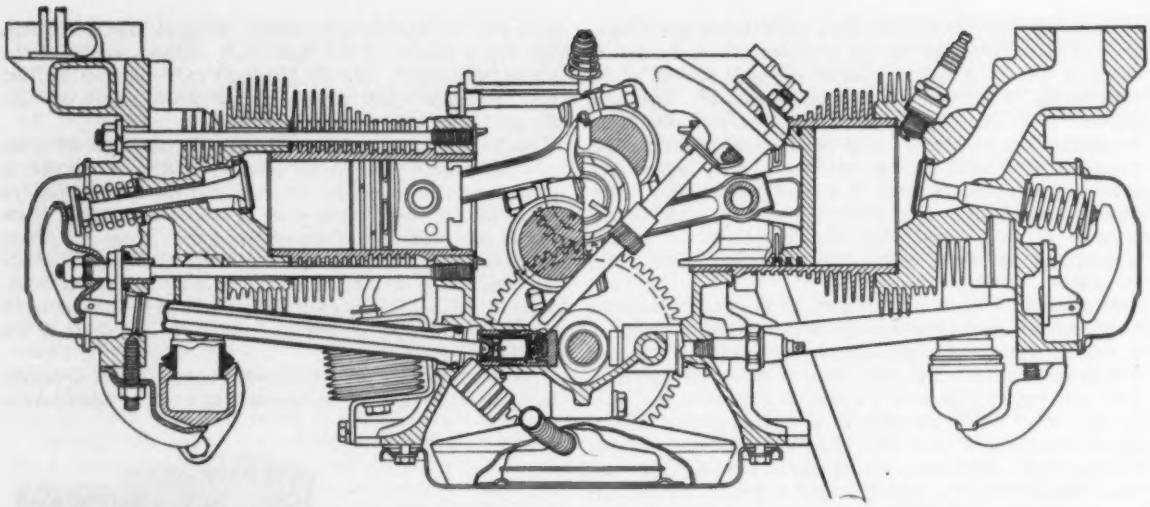
There is a noticeable trend towards the incorporation of the inlet tract in the cylinder head casting. The Rover 3-litre engine, introduced last year, has a water jacketed inlet manifold integral with the light alloy head, and the feature is repeated in the shorter-stroke version, to which reference has already been made. Integral inlet manifolds, too, are a feature of the light alloy cylinder heads of the Chevrolet Corvair. On the Falcon, Ford's compact car, the inlet manifold again is part of the head, which in this instance is an iron casting.

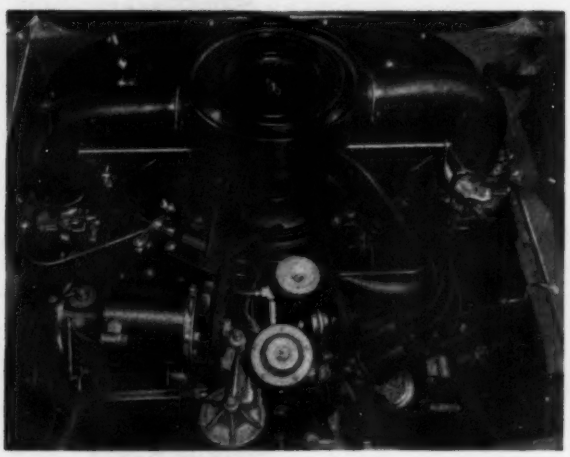
Such construction sets an obvious premium on accuracy of coring, but it obviates the possibility of malalignment of the adjacent openings in the head and manifold. Also, to offset the increased complexity of the head casting, there are no joint faces to be machined, and the appropriate gasket and additional assembly operations are eliminated. Since any machining is limited to the extremities of the tract, integral manifolding is unlikely to find a place on the more highly tuned type of engine, but it could show a net advantage on others.

Although the horizontally opposed engine layout is usually less accessible than an in-line unit in a car, it continues to find new adherents, because of its axial compactness and fundamentally good balance. In the case of the Chevrolet Corvair, its adoption was almost inevitable, once the swept volume, location and method of cooling had been decided: the unit had to be short, shallow and as light as was practicable. The only other new engine with this configuration at Earls Court was the 696 cm³ B.M.W. unit, which closely resembles the 582 cm³ engine of the earlier 600 car. Unfortunately, the Lloyd Arabella was not exhibited: it has a liquid cooled, horizontally opposed four-cylinder engine, which was briefly described in the September 1959 issue of *Automobile Engineer*.

There are various current examples of large air-cooled engines in commercial vehicles, but the Corvair must be the largest car power unit of this type since the American Franklin. Whether or not the Chevrolet engineers chose wisely remains to be seen. Nevertheless, this engine is one of the most interesting and enterprising of the newcomers, and the special problems posed by its air cooling have obviously required very careful study. With more than two cylinders in line, equalized cooling becomes virtually impossible with an axial draught, so a vertical-axis fan was evolved, mounted above the crankcase.

A method for the regulation of fan speed, known to have attracted the interest of several British car manufacturers, is the Eaton viscous fan coupling. In effect, the drive is transmitted through a thin film of silicone fluid in what is





The Chevrolet Corvair, 2,296 cm³, air cooled engine has wedge type combustion chambers. Aluminium is used for the crankcase and cylinder heads, which embody the inlet manifolds. Left: The cooling fan is mounted horizontally, and is driven by a long, notched V-belt

thus a torque-sensitive clutch. Since the clutch slips increasingly as the input speed rises above a critical figure, the power absorption by the fan is limited. This coupling is a useful means of minimizing parasitic loss at high engine speeds, but it can scarcely be denied that a temperature-sensitive device would be of greater basic merit.

Another interesting component is the Glacier DU bearing. It comprises a steel backing strip, on which is a layer of porous bronze impregnated with a mixture of p.t.f.e. and lead powder, and an overlay of the same mixture. DU bearings have been used experimentally in such applications as carburettors, distributors and linkage pivots, their principal merit being the obviation of routine lubrication and maintenance. Among the newer materials for oil seals for high temperature applications are silicone rubbers and improved synthetic rubbers such as Du Pont's Viton.

The paper-element type of air intake filter continues to find new adherents. Filters of this type are employed on the new small B.M.C. and, at the other extreme, on the Rolls-Royce V-eight engine. They are considered to be almost as effective as the oil bath type, while occupying considerably less space and costing much the same as the less efficient oil-wetted, wire-mesh filters.

An interesting engine mounting arrangement is that employed for the 848 cm³ laterally disposed power unit of the Austin Seven and Morris Mini-Minor. The engine weight is carried on a single, laterally inclined rubber sandwich unit at each end. Torque reaction is taken mainly by a rubber bushed stay from the top of the cylinder block to the dash structure; but, in addition, the exhaust pipe, which is rigidly clamped to the manifold and to the bottom of the transmission casing, provides an additional restraint through its flexible attachment to the underbody structure immediately ahead of the silencer.

Abarth

The Turin firm of Abarth has achieved widespread fame for its tuning and development work, particularly on Fiat engines, and examples of these special units were on display at Earls Court. They are of 747 and 833 cm³ swept volume, and each size is available in two forms. Only what might be called the standard models bear any marked resemblance to the Fiat 600 from which they are derived. These units have a bore and stroke of 61 × 64 mm or 62 × 69 mm, as against the 60 × 56 mm of the original engine. The crankshaft is, of course, completely new and is considerably more robust to cope with the increased power output. A new camshaft is fitted, and extensive modifications are carried out to the cylinder head and ports. The compression ratio is raised to 9·8:1 on the smaller version and 9:1 on the larger, and a larger-choke Weber carburettor is employed, together with manifolds giving improved gas-flow characteristics. A power output of 48 b.h.p. at 5,500 r.p.m. is claimed for the 747 cm³ engine, whereas that of the 833 cm³ model is 52 b.h.p. at 6,000 r.p.m.

In its other form, the Fiat Abarth engine is an impressive, twin-overhead-camshaft unit, in which the only remaining Fiat components of any significance are the cylinder block, connecting rods and flywheel, and these are considerably modified. The camshafts are chain driven, and the light-alloy cylinder head has part-spherical combustion chambers. The 747 cm³ unit shown had a compression ratio of 9·7:1 and two twin-choke Weber carburettors. Its power output is stated to be 61 b.h.p. at 6,500 r.p.m., and the larger variant is said to develop about 67 b.h.p.

Berkeley

The Excelsior 492 cm³ three-cylinder two-stroke engine, described last year, is no longer fitted in the Berkeley car; the two-cylinder unit of 328 cm³, from which it was developed, is now installed only in the recently introduced three-wheel version of the little sports car. On the four-

wheel models, derivatives of the Royal Enfield 692 cm³ parallel-twin, four-stroke motor-cycle engines are employed, and give a higher performance.

This latter engine is available in standard and tuned forms. In each case the bore is 70 mm and the stroke 90 mm. The one-piece crankshaft is of cast iron and embodies a medial balance weight; it is carried in ball and roller bearings, but orthodox split plain bearings are employed in the big ends of the light alloy connecting rods. An oil container, for the dry-sump lubrication system, is incorporated in the aluminium alloy crankcase. Following normal motor-cycle practice for parallel-twin engines, there are two relatively high camshafts, one in front of the cylinders and the other behind. The camshafts are chain driven and actuate the valves through the medium of short push rods and rockers of normal design.

Both the cylinder barrels and the heads are separate castings, the former being of iron and the latter of aluminium alloy with shrunk-in valve seats. Part-spherical combustion chambers are employed. On the standard version of the engine, which has a compression ratio of 7·25:1, the carburettor is an Amal Monobloc, but an Amal 10TT9 carburettor, of racing type and with a larger choke, is fitted to the higher performance unit, which has a compression ratio of 8:1 and camshafts giving a higher lift and more valve overlap.

A duplex roller chain transmits the drive from the left-hand end of the crankshaft to the clutch and gearbox. Within the chaincase, adjacent to the engine sprocket, is an external flywheel carrying the toothed ring for the starter, which protrudes laterally from the case. The engine is supported at the front by a cross tube welded to plates bolted to the crankcase; sandwich type rubber mountings are interposed between the outboard ends of the tube and bearer arms on the vehicle. At the rear, the unit sits directly on a rubber mounting on a bearer arm.

A gross power output of 40 b.h.p. at 5,500 r.p.m. is quoted for the standard engine, the torque of which is 43 lb-ft at 4,150 r.p.m. The corresponding figures for the more highly tuned engine are 50 b.h.p. at 6,250 r.p.m., equal to 72.4 b.h.p./litre, and 45 lb-ft at 5,550 r.p.m.

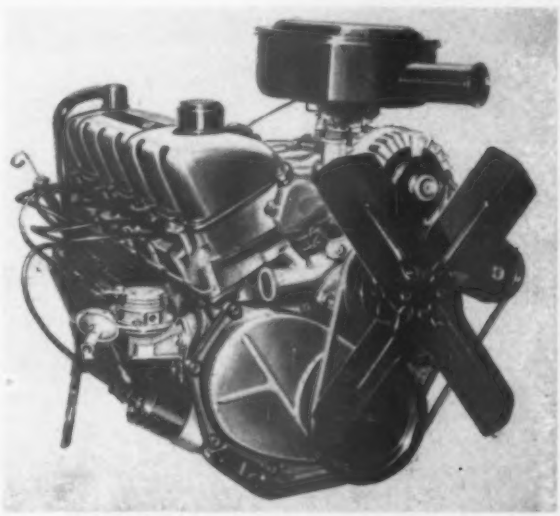
B.M.C.

Although the 848 cm³ engine of the Austin Seven and Morris Mini-Minor is new, it is virtually a short-stroke version of the highly successful Series A unit of 948 cm³, with a different clutch and the gearbox housed in the magnesium-alloy sump. The 62·9 mm bore of the Series A engine is retained but the stroke is reduced from 76 mm to 68·26 mm, giving a stroke:bore ratio of 1·08:1 instead of 1·21:1. Since the connecting rods are common to those of the larger engine, the ratio of their length to the stroke is relatively high. To maintain the compression ratio at 8·3:1, the piston height from gudgeon pin to crown has been increased.

The combustion chamber is of the familiar B.M.C.-Weslake heart shape, and the valves are vertical. The maximum gross power output is 37 at 5,500 r.p.m., the same as that of the Series A engine of the Morris Minor 1000 at 4,800 r.p.m.; the maximum gross torque is 45 lb-ft at 3,450 r.p.m.

No changes of any consequence have been made to the Series A engine or to the Series B, 1,489 cm³ design. Mention should be made, however, of the Shorrock-supercharged version of the Series A model, now available on the Austin-Healey Sprite car. This has the standard compression ratio of 8·3:1 and is stated to have a maximum power output of 86 b.h.p. at 6,000 r.p.m., at a blower pressure of 6 lb/in². Its reliability at this high output remains to be proved, however.

The swept volume of the Series C, six-cylinder engine has been increased from 2,639 cm³ to 2,912 cm³ by enlarging the bore from 79·4 mm to 83·34 mm. Since the stroke of 89 mm is unchanged, the stroke:bore ratio has come down from 1·12:1 to 1·07:1. The compression ratio is unaltered at 8·3:1 and the valve sizes, too, are as before. At 4,750 r.p.m., the maximum gross power output is 108 b.h.p., and the maximum torque of 157 lb-ft occurs at 2,300 r.p.m.



Above, right: On the Plymouth Valiant unit, of 2·8 litres swept volume, the cylinder axes are inclined to the right at 30 deg to the vertical. Among the interesting features are a camshaft drive by inverted-tooth chain, an alternator, and a long induction system

Right: The third of the American compact cars, the Ford Falcon, has a six-cylinder engine of 2,365 cm³ swept volume. One of the few departures from U.S.A. practice is the use of bath tub combustion chambers

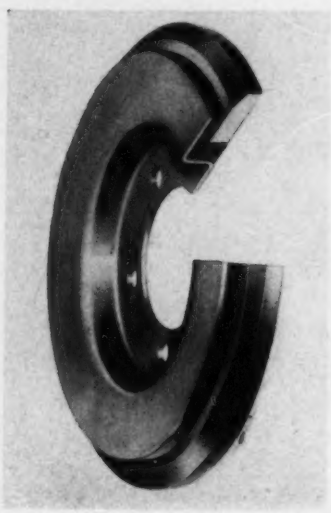
The more highly tuned variant fitted to the Austin-Healey 3000 has a compression ratio of 9·03:1 It produces 130 b.h.p. at 4,750 r.p.m and its torque of 175 lb-ft is developed at a speed of 3,000 r.p.m.

B.M.W.

In design, the 696 cm³ horizontally opposed, air-cooled, twin-cylinder engine of the new B.M.W. 700 rear-engine cars closely follows the practice long established by the Company for its motor-cycle power units and found on the 600 engine exhibited last year. This new car engine has a bore and stroke of 78 and 73 mm respectively; the stroke:bore ratio of 0·94:1 is rather higher than that of the 600 unit. The crankshaft is of built-up construction and roller big-end bearings are employed.

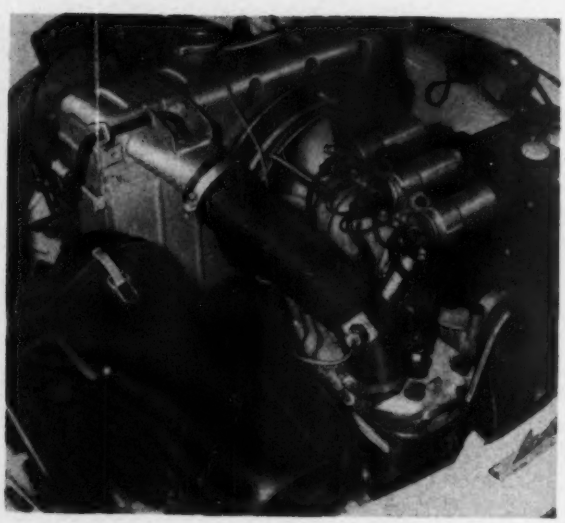
A single gear-driven camshaft, above the crankshaft, actuates the push rods through the medium of self-adjusting tappets. The combustion chambers in the light-alloy cylinder heads are of part-spherical form. There are the lengthy induction pipes inevitable with this cylinder layout and a single carburettor. An unusual detail, however, is their attachment to stubs on the cylinder heads by two lengths of rubber hose, secured by clips. Warmed air is supplied to the carburettor when necessary through a flexible pipe leading from an exhaust system jacket to the air filter. The cooling fan is mounted on the outboard end of the armature of the starter-generator unit, at the rear end of the crankshaft.

The engine has the moderate compression ratio of 7·5:1. Though its power output is proportionately higher than that of the de-rated 600 unit, it is still by no means high at 30 b.h.p., D.I.N. rating, at 5,000 r.p.m. The maximum torque developed is 32·25 lb-ft at 3,200 r.p.m.



A Metalastik torsional vibration damper of the bonded rubber type is a feature of Rolls-Royce's new V-eight power unit

Below: The D.K.W., 741 cm³, two-stroke engine is of similar basic design to the 980 cm³ unit. It has a coil for each cylinder, and the fan is mounted on the generator shaft



Chevrolet

The Corvair horizontally opposed, six-cylinder air cooled engine of 2,296 cm³ unit is technically highly interesting. With a bore of 85·7 mm and a stroke of 66 mm, it has the low stroke:bore ratio of 0·77:1. This engine has a compression ratio of 8:1, and its power output is stated to be 80 b.h.p. at 4,400 r.p.m.; no torque figures have yet been divulged.

Owing to its vertically split form, the crankcase is extended well below the crankshaft axis, to give adequate support to the main bearing housings. The underside of the case is closed by a pressed steel sump. Four main bearings, 2·1 in in diameter, are employed, and the diameter of the crankpins is 1·8 in. Because of the inherently good balance of the horizontally opposed, six-cylinder layout, the sturdy forged crankshaft is not counterweighted. To keep the width of the engine as small as possible, the connecting rod:stroke ratio is lower than usual, at 1·81:1.

The separate cast iron, shell moulded cylinders are deeply spigoted into the crankcase apertures, and are secured by the studs holding down the one-piece, aluminium cylinder heads. Each of these head castings embodies its inlet manifold and carburettor riser. The combustion chambers are a combination of the offset bath tub and wedge forms; not only is the roof of each chamber inclined, as viewed in front elevation, but also it is of double pent-house form, as viewed in plan, to splay the valves to suit the camshaft and push rod layout.

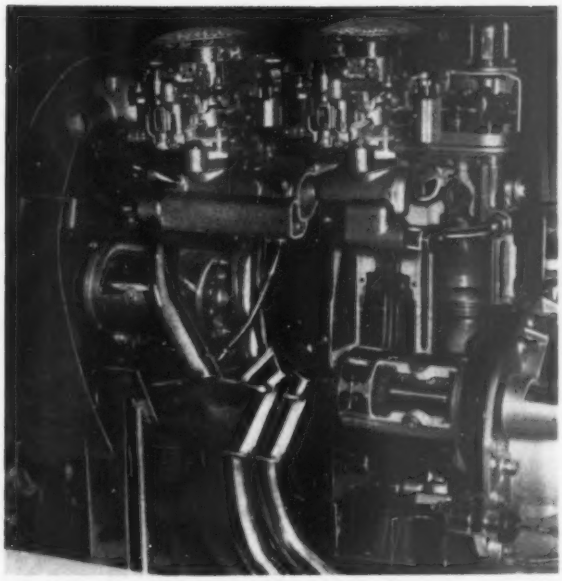
Relatively small valves are employed, widely spaced to make room for a finned air space between the spring housings. The valves seat on cast steel inserts and are actuated by pressed steel rockers with hemispherical pivots. A gear drive is employed for the camshaft, which lies below the crankshaft and actuates the push rods through the medium of hydraulic tappets. The push rods are enclosed in steel tubes, sealed to the crankcase and cylinder heads.

The horizontally positioned cooling fan has 24 blades and a diameter of 11 in. It is driven at 1·58 times crankshaft speed by a notched vee-belt. The drive is turned through the necessary 90 deg by the generator pulley on one run and an adjustable idler on the other. Between one pulley and the next, the belt has, of course, to twist through 90 deg. A thermostatically controlled throttle-ring in the blower intake adjusts the rate of air flow according to the engine operating temperature.

Coventry Climax

It is fitting that, at the end of a highly successful first season in Cooper racing cars, the remarkable Coventry Climax 2½-litre FPF engine should be briefly described here. This engine is the latest addition to the FPF series, the earlier examples being the 1½-litre unit and its 2-litre and 2·2-litre derivatives. The 2,495 cm³, 94 × 89·9 mm engine has a close superficial resemblance to the 2-litre model, but it actually has an entirely new crankcase-block casting, to permit wider spacing between the cylinder axes.

This casting is, of course, of light alloy and is externally ribbed for stiffness and cooling, is extended well below the crankshaft axis and has wet cylinder liners. The counterweighted crankshaft is very carefully balanced and is carried in five main bearings. A feature of the fully machined



The two-carburettor layout shown on the left is that of the Sunbeam Alpine 1,494 cm³ engine; the manifold is water heated, and the exhaust system provides good gas flow. A less elaborate arrangement is used on the 948 cm³ unit of the Triumph Herald coupé, developed from that previously installed in the Standard Ten and Pennant cars. These two engines develop 83·5 and 50·5 b.h.p. respectively

connecting rods is the use of two circumferential ribs round the big ends, to prevent any tendency towards bell-mouthing. Dry sump lubrication is employed, and the oil pump is driven, by a spur and spiral gear train, from the front of the crankshaft.

The two overhead camshafts are driven by a train of straight-tooth gears. They actuate the valves through the medium of inverted bucket type tappets in cast iron guides. These guides are pressed into magnesium alloy sandwich pieces which, positioned between the head and the camshaft covers, also form the housings for the lower halves of the split plain bearings for the camshafts. This arrangement is the same as was used on the smaller engines. The valves are as large as can conveniently be accommodated; the inlet valves are inclined at 32 deg to the vertical, whereas the exhaust valves are at 34 deg. Both sets of valves are of Nimonic 80 material. The inlet seatings are of austenitic steel and the others of a high-duty bronze. There is one sparking plug per cylinder: the plugs have a radial disposition relative to the combustion chamber, and are inclined alternately to the rear and front of the cylinder axes, to bring their holes clear of the valves.

Two Weber twin-choke carburettors, of 58 mm bore, are fitted, at a slight downdraught angle. The length of the induction pipes is selected to give the optimum ram effect over the part of the speed range most used under racing conditions.

Appreciable curvature is given to the induction ports, to ensure sufficient turbulence for good combustion at lower r.p.m. Running on standard racing fuel, and with a compression ratio of 11·9:1, this engine has a power output of 236 b.h.p. at 6,750 r.p.m., at which rate the mean piston speed is 3,980 ft/min. The torque curve peaks at 5,000 r.p.m., at which speed its value is 210 lb-ft.

Further development of the FPF 1,475 cm³ engine has been carried out during the past year, as a result of which its power output has been increased to 142 b.h.p. at 7,000 r.p.m. This engine has a bore of 81·3 mm and a stroke of 71·2 mm. On the FWE 1,216 cm³ single camshaft engine fitted to the Lotus Elite car, the compression ratio has been raised from 8·5:1 to 10:1. With a single S.U. 1½ in carburettor, this unit now develops 75 b.h.p. at 6,100 r.p.m., as against the 70 b.h.p. at 5,500 r.p.m. of the previous version. The bore and stroke are respectively 76·2 mm and 66·6 mm, and the weight is given as 215 lb.

Daimler

A major departure from tradition by the Daimler Co. has been the introduction of two new 90 deg V-eight engines, one of 2½ litres and the other of 4½ litres. The smaller, which was the first to be announced, is fitted to the SP250 sports car and the other is in the Majestic Major.

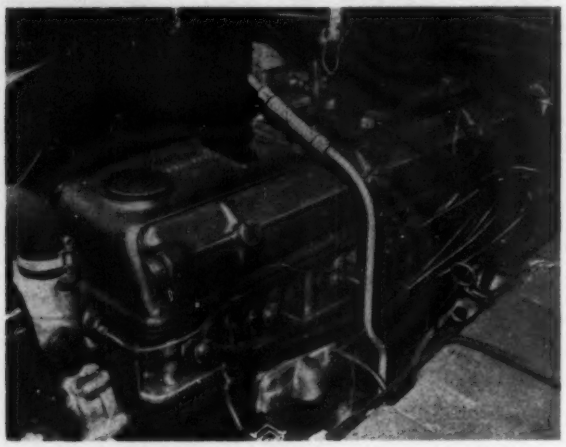
The smaller unit has a bore of 76·2 mm and a stroke of 69·85 mm, while the larger measures 95·25 × 80·01 mm; the actual swept volumes are thus 2,548 and 4,560 cm³, and the stroke:bore ratios 0·917:1 and 0·834:1. In each instance, an iron crankcase-block casting is employed. The crankshaft has five main bearings, and the connecting rods are disposed one behind the other on the crankpins. A single, chain-driven camshaft is carried in the angle between the banks of cylinders. It actuates the valves through the medium of push rods and rockers; there are separate shafts for the inlet and the exhaust rockers of each bank, because of the use of part-spherical combustion chambers. Aluminium is employed for the cylinder heads. The compression ratios of the two are respectively 8·2:1 and 8·0:1.

To avoid masking of the air flow, the radiator fan of the smaller engine has an unusually long boss, which brings it well ahead of the crankcase. The belt-driven generator is mounted between the cylinder banks. According to the manufacturers, the gross power output of the SP250 engine is 140 b.h.p., or approximately 56 b.h.p/litre, at 5,800 r.p.m., and its maximum torque is 155 lb-ft at 3,600 r.p.m. For the 4½-litre engine, the output is said to be 220 b.h.p. at 5,500 r.p.m.; this is equal to about 49 b.h.p/litre. Torque figures have not yet been released.

Fiat

Since the last Earls Court Show, Fiat has introduced two new engines. The first of these is a six-cylinder unit, made with alternative bore sizes to give it a swept volume of 1,795 or 2,054 cm³. In each case, the stroke is 73·5 mm. An outstanding feature of the engine is probably its polyspherical combustion chambers, in which there are four

spherical segments of different radii. These chambers are fully machined, and the compression ratio is 8·8:1. The obliquely disposed inlet and exhaust valves are inclined at different angles to the vertical. There are separate rocker shafts for the inlet and exhaust systems, and the inclinations of the two sets of push rods are almost identical. On an



Of similar basic design to the Isabella engine, the new Borgward, 2·3-litre, six-cylinder unit has an aluminium rocker gear cover embodying the inlet manifold. The side cover gives access to the valve clearance adjusters

S.A.E. basis, the power outputs are 85 b.h.p. for the 1800, and 95 b.h.p. for the 2100 unit, both at 5,000 r.p.m. The maximum torque figures are respectively 105 and 123 lb-ft at 3,000 r.p.m.

A more recent introduction is the 1500 engine, based on the Osca sports racing unit. It has square bore and stroke dimensions of 78 mm, giving a swept volume of 1,491 cm³. The crankcase-block casting is of iron and the cylinder head is of aluminium alloy, with inserted valve seats. Five main bearings carry the crankshaft. The two overhead camshafts are chain driven, and part-spherical combustion chambers are employed, with the sparking plugs vertically disposed; the compression ratio is 8·6:1. The two-choke downdraught carburettor is mounted on a horizontal manifold feeding separate inlet ports. The oil filter is of the centrifugal type. A net power output of 80 b.h.p. at 6,000 r.p.m. is quoted by the manufacturers, and the S.A.E. output rating is given as 90 b.h.p. at that speed.

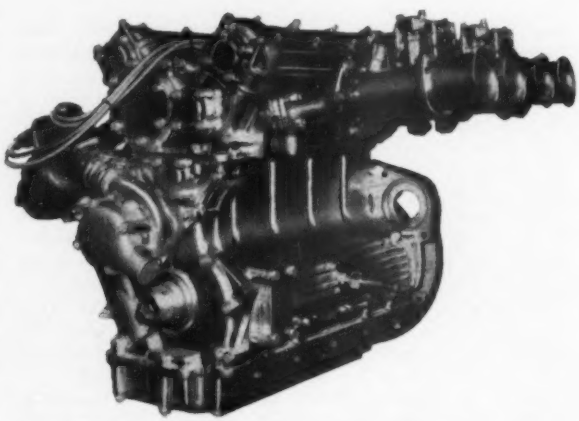
Ford (Great Britain)

The entirely new Anglia 105E, 997 cm³ engine has the distinction of having the lowest stroke:bore ratio of any production unit; its bore and stroke are respectively 80·96 mm and 48·41 mm, giving a ratio of just under 0·6:1. As a result of this short stroke, the cylinder block is unusually short and rigid, and there is ample length for the main bearings. The engine follows Ford practice in having a cast iron crankshaft which, again because of the short stroke, has a considerable bearing overlap. This shaft has hollow flying webs and journals. Not only is weight saved by this means, but the strength is increased because there are two tough skins, internal and external, unbroken by machining, over much of the shaft's length. The shaft is not counterweighted, owing to the ample bearing size and low out-of-balance mass. Secondary forces are reduced by the use of unusually long connecting rods: the ratio of their length to the stroke is no less than 2·43:1.

In most other respects, the Anglia engine is relatively orthodox. It has a chain-driven side-mounted camshaft actuating mushroom type tappets, which run directly in the cylinder block, as do the vertical valves in the cast iron cylinder head; the combustion chambers are of bath tub form. To ensure equality of clearance volumes, and so to permit the use of a compression ratio as high as 8·9:1, the chambers are fully machined. Individual ports are employed, and the inlet ports have an appreciable down-draught angle. Oil loss down the valve guides is minimized by inverted cups, of synthetic rubber, which are fitted to the upper ends of the valve stems and are embraced by the single coil springs.

Two interesting departures from convention are the exhaust valves and the oil pump layout. The exhaust valves are of two-piece design, in which heads of DTD49B alloy steel are butt welded to the En.18D stems, which material is used also for the inlet valves. Instead of the eccentric-lobe oil pump being carried in the sump, it is embodied in the oil filter housing, mounted externally on the right-hand side of the engine; the housing also incorporates the pump relief valve. This arrangement means a higher suction lift, and necessitates a self-priming type of pump, but results in a very accessible pump.

The maximum gross power output of the new Anglia engine is 41 b.h.p. at 5,000 r.p.m. Its power curve is almost identical with that of the 100E, 1,172 cm³ side valve unit up to 3,000 r.p.m., beyond which it diverges upward; the 100E engine produces 38 b.h.p. at 4,500 r.p.m. Likewise,



The Coventry Climax, 2½-litre, FPF racing engine has a bore of 94·0 mm and a stroke of 89·9 mm; there are three Weber twin-choke carburettors, and the compression ratio is 11·9 : 1. The power output is 236 b.h.p.

the torque curves are similar up to 3,000 r.p.m., a little above the torque peak of 2,700 r.p.m. The maximum gross value of the torque is 55 lb-ft, and the b.m.e.p. of the 105E engine is about 20 lb/in² higher than that of the 100E over most of the speed range.

Ford (U.S.A.)

Unfortunately, little technical information was available on the power unit of the Ford Falcon. It is clear, however, that the engine is a decidedly orthodox 2,365 cm³ six-cylinder unit. Appreciably over-square cylinder dimensions have been adopted, the bore being 88·9 mm and the stroke 63·5 mm. The cylinder block and head castings are both of iron, and the compression ratio of 8·7:1 is modest by current American standards. Combustion chambers of bath tub form are employed, and the valves are inclined at a small angle to the vertical.

The power output is given as 90 b.h.p. at 4,200 r.p.m., and its superiority to the Zephyr engine's 85 b.h.p. at 4,400 r.p.m.

may be attributable to the lower compression ratio of the Zephyr and to the S.A.E. test conditions applying in the case of the Falcon unit. A maximum torque of 138 lb-ft is developed at 2,000 r.p.m.

Jaguar

As installed in the Jaguar Mark 2 car, the 2·4-litre six-cylinder engine has been improved for 1960 by the adoption of the B type cylinder head. This was formerly fitted only to the standard versions of the 3·4-litre and 3·8-litre units. Its porting gives better gas flow than the earlier head. As a result, the power has gone up from 112 to 120 b.h.p. at 5,750 r.p.m., and the torque has risen from 140 to 144 lb-ft at 2,000 r.p.m.

No changes have been made to the standard and S series 3·4-litre engines, but the 3·8-litre unit, previously fitted only to the Mark IX car, in its standard form, is now available, both in this and as the S series version, for the XK 150 cars. In both sizes, the conversion to S specification involves the fitting of a different cylinder head, having straight instead of curved inlet ports, a higher compression ratio—9:1 instead of 8:1—and an altered inlet manifold carrying three S.U. carburettors instead of two. The 3·8-litre S series engine has the high output of 265 b.h.p. at 5,500 r.p.m. and its maximum torque is 260 lb-ft at 4,000 r.p.m.

Mercedes-Benz

The six-cylinder 2,195 cm³ engine of the new 220 S car is very similar to that of the previous model of the same designation. It retains the 80×72·8 mm cylinder dimensions, the single overhead camshaft actuation of the valves, and the compression ratio of 8·7:1. However, the rocker layout has been modified, as has the form of the cams, and the size of the compound Solex downdraught carburettors has been increased. As a result of these changes, the gross power and torque have both increased, the former from 120 b.h.p. at 5,000 r.p.m. to 124 b.h.p. at 5,200 r.p.m., and the latter from 137 lb-ft at 3,800 r.p.m. to 139 lb-ft at 3,700 r.p.m.

Moskvitch and Volga

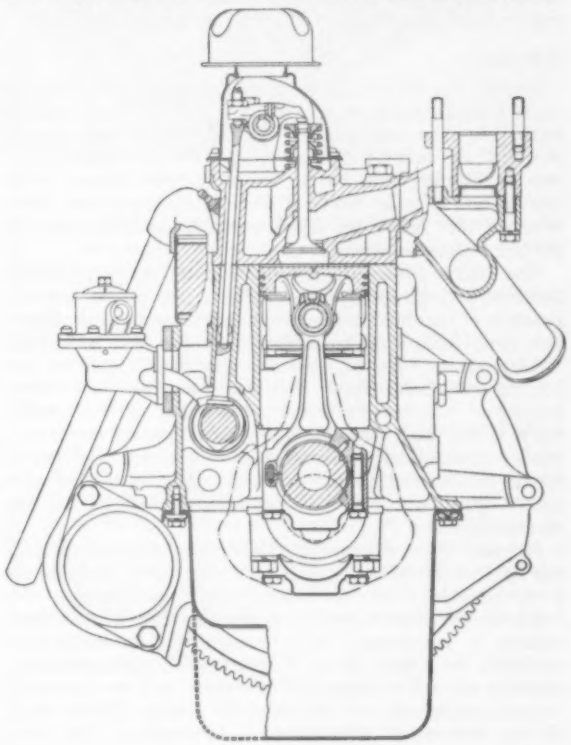
Although the first cars from the U.S.S.R. to reach this country attracted considerable interest, it can hardly be claimed that their engines are of advanced design. However, another few years may see considerable changes. The engines in the cars exhibited were the 1,360 cm³ Moskvitch and the 2,445 cm³ Volga, both four-cylinder units.

Slightly over-square cylinder dimensions of 76×75 mm have been adopted for the new overhead valve Moskvitch engine. It has a cast iron cylinder block and head, and is unusual in having the water jacketed inlet manifold on the left, fed by a downdraught carburettor, and the exhaust manifold on the other side. The compression ratio of 7:1 is to cater for fuel of only 72 octane. There is a manual overriding control for the ignition timing, and the radiator has shutters—a reminder of Russia's winter climate. A modest power output of 45 b.h.p. at 4,500 r.p.m. is quoted, and the maximum torque is 65·1 lb-ft at 2,500 r.p.m.

The Volga engine has aluminium cylinder head and block castings, and wet liners. It has an equal bore and stroke measurement of 92 mm, and the crankshaft has five lead-bronze lined bearings. The lubrication system embodies a floating oil intake to the pump, a coarse full-flow filter and a cartridge type by-pass filter. Its valve head diameters are noticeably small and the combustion chambers are of the orthodox bath tub form.

This engine normally has a compression ratio of 6·6:1, but it is raised to 7·5:1 for export markets. With the higher ratio, the power output is 80 b.h.p. at 4,000 r.p.m. The maximum torque is 130 lb-ft, but the speed at which it occurs is not specified.

Cross-sectional view of the Ford Anglia engine. The combustion chambers are fully machined and the inlet ports have considerable downdraught. A cast iron crankshaft is fitted; it has hollow flying webs and journals



Plymouth

The largest and most powerful of the engines in the three American compact cars, the 2·8-litre Plymouth Valiant is, like the Ford Falcon, an in-line six-cylinder unit. It differs however, in having the cylinder axes inclined to the right at 30 deg to the vertical. In addition to reducing the height of the installation, this layout has permitted the use of unusually long induction manifolding without the penalty of excessive width.

A bore of 86·4 mm and a stroke of 79·4 mm have been

COMPARISON OF COMPRESSION RATIOS

	British			Continental			U.S.A.		
	Average compression ratios		*Increase, per cent*	*Average compression ratios*		*Increase, per cent*	*Average compression ratios*		*Increase, per cent*
	1957	1960		1957	1960		1957	1960	
Below 1,000 cm³	7·98 : 1	8·12 : 1	1·7	6·92 : 1	7·60 : 1	9·8			
1,000 to 1,500 cm³	7·70 : 1	8·65 : 1	12·3	7·38 : 1	2·70 : 1	4·3			
1,500 to 2,000 cm³	7·69 : 1	8·34 : 1	8·4	7·73 : 1	8·30 : 1	7·3			
Over 2,000 cm³	7·64 : 1	8·08 : 1	5·7	7·57 : 1	8·02 : 1	5·8	8·82 : 1	9·37 : 1	6·2

adopted, giving the over-square stroke : bore ratio of 0·92 : 1. The four-bearing crankshaft has considerable bearing overlap, and the high-mounted camshaft is driven by an inverted-tooth chain, a type of drive nowadays confined to the U.S.A. Cast-in steel struts control the expansion of the slipper skirt pistons.

The cylinder head embodies combustion chambers of wedge form, and the compression ratio is 8·6 : 1. Solid tappets and tubular push rods are employed, and the rockers are steel pressings. The single-throat carburettor has an unusual torsion bar throttle linkage. A power output of 101 b.h.p. at 4,400 r.p.m. is quoted for the Valiant engine, and its maximum torque is 155 lb-ft at 2,400 r.p.m.

Rolls-Royce

Perhaps the most remarkable thing about the beautifully made Rolls-Royce 6¼-litre V-eight engine is that it should weigh no more than the 4·9-litre six-cylinder unit that it replaces. To achieve this low weight, the new engine, used also in Bentley cars, has a crankcase and cylinder block casting, and cylinder heads, of high-silicon aluminium alloy. Wet cylinder liners are fitted, and cooling is effected by inhibited glycol, not water.

The fully balanced crankshaft runs in copper-lead bearings, and this material is employed also for the big-end bearings of the tandem-mounted connecting rods. A departure from Rolls-Royce tradition is the use of a Metalastik bonded-rubber type of torsional vibration damper on the leading end of the shaft. The single cast iron camshaft is positioned between the cylinder banks and carries a light-alloy, helical gear, meshing with a steel gear on the crankshaft. Hydraulic tappets and push rods actuate the valves, which are inclined inward from the plane of the cylinder axes. They are relatively small for an engine of this displacement.

A wedge form of combustion chamber has been adopted, but its 28 deg roof angle is greater than usual and there is a considerable squish area opposite to the sparking plug. To minimize the exposed surface of the chamber, the clearance volume is augmented by a toroidal depression in the middle of the piston crown. This chamber and valve layout has kept the width down to a minimum, and the engine is, in fact, appreciably narrower than the smaller Daimler unit. In the interest of refinement of performance, the compression ratio has been deliberately restricted to the moderate figure of 8 : 1.

In front of the crankshaft vibration damper is a four-groove pulley. Two of the belts drive the tandem fan and water pump, and the oil pump for the powered steering, while the other two drive the generator and the compressor for the refrigeration section of the air conditioning equipment. It is to be regretted that, in accordance with their custom, the manufacturers have not released any power and torque figures for this outstanding engine.

Rootes Group

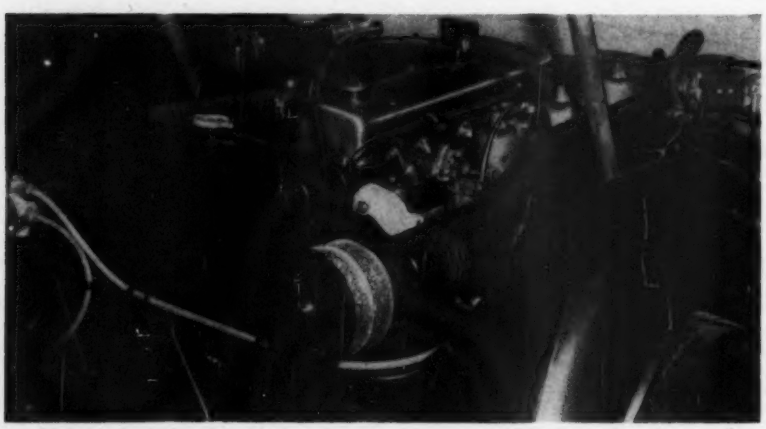
Although there is no entirely new Rootes engine for 1960, the power output of each of the 1½-litre four-cylinder versions has been increased, and the six-cylinder Super Snipe engine has been increased in swept volume from 2,651 to 2,951 cm³. The number of variations of the basic 1,494 cm³ engine has, in fact, been increased from three to four, with the introduction of the Sunbeam Alpine sports model, but the engine in this is virtually the same as that in the Rapier. Other versions are in the Minx and Gazelle.

In all cases, the bore and stroke are respectively 79 mm and 76·2 mm, the bore having been increased from its previous 76·2 mm last year. The development process has been, in effect, the upgrading of the two lower-power engines, in the Minx and Gazelle, and the adoption of a new cylinder head and manifolding for the other two. Thus, the Minx unit now has virtually the previous Gazelle manifolds, with a different carburettor, and the Gazelle has the Rapier two-carburettor set-up of last season, though the carburettors themselves, again, are of a different type. Both engines retain the 8·5 : 1 compression ratio that was used hitherto.

The latest Minx version has a gross power output of 56·5 b.h.p. at 4,600 r.p.m., an increase of 4 b.h.p. from last year. Its maximum torque is 83 lb-ft at the moderate speed of 2,000 r.p.m. The Gazelle two-carburettor unit produces 64 b.h.p., also at 4,600 r.p.m., which again is 4 b.h.p. more than the 1959 figure; maximum torque is almost identical with that of the Minx, but occurs at 2,400 to 2,800 r.p.m. In the case of the Minx engine, the torque increase afforded by the modifications is 5 lb-ft, while the figure for the Gazelle is hardly changed.

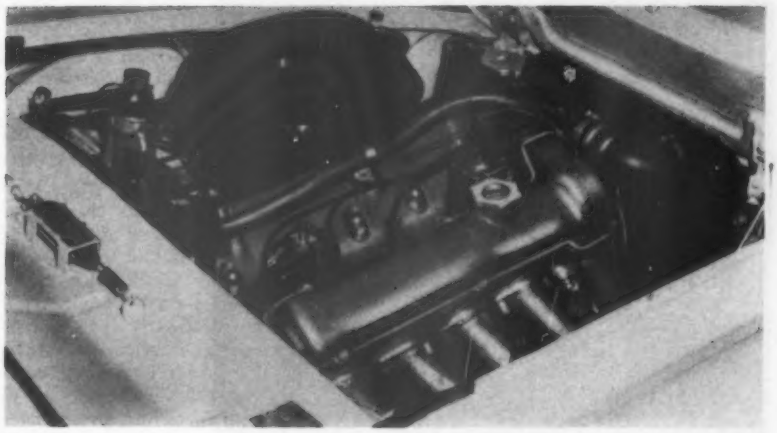
An aluminium alloy cylinder head is fitted to the variants in the Sunbeam cars. This head permits the use of a considerably higher compression ratio, 9·2 : 1. It has slightly inclined, instead of vertical, valves, and this has improved the gas flow and the water passage arrangement round the exhaust valves. The porting is so arranged that no two exhaust valves are adjacent.

The Alpine engine has the high gross power output of 83·5 b.h.p. at 5,300 r.p.m., and its maximum torque is 89·5 lb-ft at 3,400 to 3,800 r.p.m. In its Rapier form, with a different exhaust manifold and air filter arrangement, the unit produces 78 b.h.p. at the same speed, and its torque is 83 lb-ft at 3,500 r.p.m. This output is 5 b.h.p. more than that of last year's Rapier engine, and the torque has risen by 1·7 lb-ft, though it now occurs at a rather higher speed.

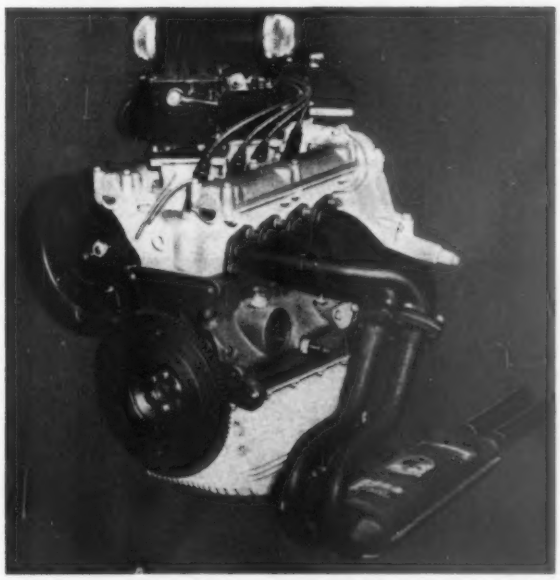


The Jensen 541R sports saloon is equipped with the B.M.C. 3,993 cm³, three-carburettor engine; both the air filter and the petrol pump are mounted ahead of the radiator. A compression ratio of 7·4 : 1 is employed

Right: An interesting new Fiat engine is the 1,491 cm³, four-cylinder unit of basically Osca design. It has two overhead camshafts and an aluminium alloy cylinder head. With an 8·6 : 1 compression ratio it develops 80 b.h.p. at a speed of 6,000 r.p.m.



Below: Hardly recognizable as being derived from the Fiat 600, the Abarth 747 cm³ sports engine has two overhead camshafts and a light alloy cylinder head. The compression ratio is 9·7 : 1, and two Weber twin-choke carburettors are fitted; the claimed power output is unusually high at 61 b.h.p. at 6,500 r.p.m.



A stroke of 82·55 mm is retained on the Humber Super Snipe engine, but the bore has been increased from that figure to 87·31 mm. The compression ratio has been raised from 7·5 : 1 to 8 : 1, but the valves and ports are unchanged. As a result of the two modifications, the gross power output has increased from 112 to 129 b.h.p. at 4,800 r.p.m., while the torque has gone up from 138·3 lb-ft at 1,600 to 2,400 r.p.m. to 162 lb-ft at 1,800 r.p.m., a proportionately greater improvement.

Finally, the 1,390 cm³ Husky engine, with equal bore and stroke of 76·2 mm, has had its compression ratio raised from 7 : 1 to 8 : 1. A new type of Zenith downdraught carburettor is fitted. These changes have resulted in an increase of 9 b.h.p. in the gross power output, now 51 b.h.p. at 4,400 r.p.m., and the torque has risen from 66·4 lb-ft at 1,600 r.p.m. to 72 lb-ft at 2,200 r.p.m.

Rover

For 1960, the range of Rover car engines has been reduced from five to three. The 3-litre unit introduced last year is unchanged, but the 1,997 cm³ and 2,230 cm³ engines of the 60 and 75 models have been discontinued, as has the 2,638 cm³ engine that, in its two forms, powered the 90 and 105 cars. In their place are a 2,286 cm³ four-cylinder unit, for the model 80, and a 2,625 cm³ version of the 3-litre engine for the model 100.

The 2·6-litre engine closely resembles the 3-litre unit except for a reduction in the stroke from 105 mm to 92·08 mm. No change is made to the bore of 77·8 mm, so the stroke : bore ratio is 1·18 : 1. Apart from the shorter-throw crankshaft, which is again carried in seven bearings, the lower half of the engine is unaltered.

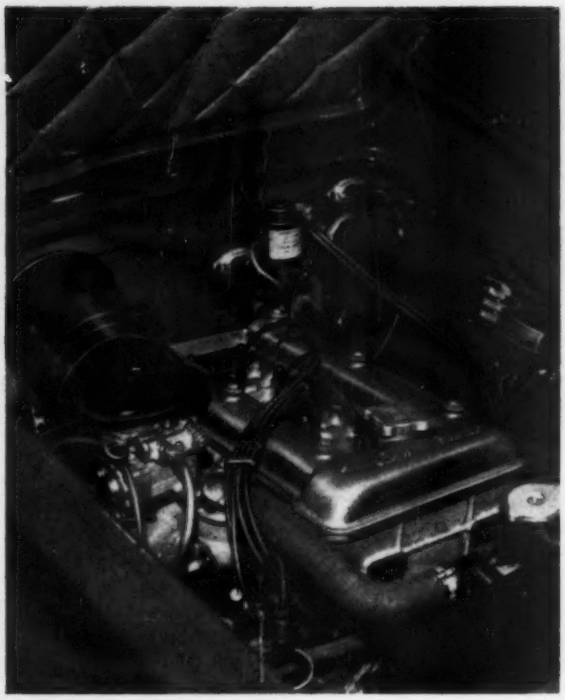
It may be recalled that the 3-litre engine has the familiar Rover F-head layout and a light alloy cylinder head casting. This layout is continued on the shorter-stroke version, and the use of the same design of pistons is reflected in the reduction in the compression ratio from 8·75 : 1 to 7·8 : 1. The new engine has a smaller-bore S.U. carburettor and a modified air filter layout to suit installational differences. Its gross power output is 104 b.h.p. at 4,750 r.p.m., and its maximum torque is 138 lb-ft at the unusually low speed of 1,500 r.p.m.

As has already been indicated, the Rover 80 engine is derived from the Land-Rover power unit. Its cylinder dimensions are 90·49 × 88·9 mm, so it is the company's only car engine with a stroke : bore ratio below unity. The robust three-bearing crankshaft has main journals of 2½ in diameter, and the big-end journals have a diameter of 2⅛ in, so there is a considerable overlap. A roller chain drives the relatively high camshaft, and the shoe type tappets carry roller followers.

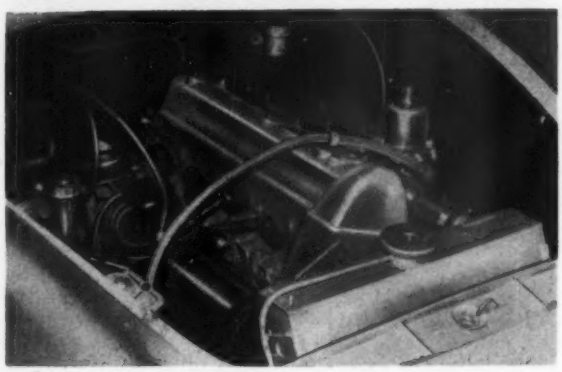
In its upper half, the engine is entirely different from the other two and, in fact, marks a reversion to orthodoxy. The head joint face is horizontal, and the valves are mounted in line in the iron cylinder head. Combustion chambers of kidney shape are cored in the head: their roofs are slightly sloping to give a valve stem inclination of 10 deg from the vertical. The head has individual inlet and exhaust ports, all on the left. Since the compression ratio is only 7 : 1, there is clearly still plenty of scope for development. At present, the maximum engine speed is 4,250 r.p.m., at which the power output is 77 b.h.p. gross. The maximum torque is 124 lb-ft at 2,500 r.p.m.

Miscellaneous—British

One of the earliest car engines to have an aluminium block-crankcase casting, the familiar A.C. 1,991 cm³, six-cylinder unit, has been modified in minor respects. Of the long-stroke type, it has cylinder dimensions of 65 × 100 mm. The valves are actuated by a single overhead camshaft. Rather surprisingly, cast iron is retained for the cylinder head. The crankshaft is now of Nitralloy steel, and connecting rods of improved design are fitted; copper-lead is



Left: One of the most beautifully made production engines is the Alfa-Romeo 1,290 cm³, twin-overhead-camshaft unit. The bonnet lid of the Spider model is glass fibre insulated. Below: The Coventry Climax 1,216 cm³ engine of the Lotus Elite develops 75 b.h.p. at 6,100 r.p.m.



employed for the big-end and main bearings. By means of an increase in the compression ratio, to 9·1 : 1, and one or two detail changes, the gross power output has risen from 90 to 102 b.h.p., at 5,000 r.p.m.

Earlier this year, a new cylinder head was introduced on the Alvis 2,993 cm³ six-cylinder engine. Though still of cast iron and with bath tub type combustion chambers, this head provides better breathing at high r.p.m. by having individual inlet ports in place of the previous siamesed arrangement. The compression ratio was raised at the same time from 8 : 1 to 8·5 : 1, and the two S.U. H4 carburettors were replaced by HD6 units.

An improved piston and connecting rod assembly was adopted: previously the rods had split small-end eyes, which clamped the gudgeon pins, but the eyes are now bushed and the pins are fully floating. Another improvement is the incorporation of a full-flow oil filter. An increased power output has resulted from the better breathing and higher compression. It has actually risen from 104 b.h.p. at 4,000 r.p.m. to 120 b.h.p. at 5,000 r.p.m.; maximum torque is only slightly improved from the 152·3 lb-ft of the earlier engine, but it occurs at about 3,000 r.p.m. as against 2,500 r.p.m.

The Fairthorpe range has been augmented by the addition of the high-performance Zeta model, fitted with a Ford Zephyr 2,553 cm³ engine. This unit departs from the standard specification in the use of a Raymond Mays cylinder head and six Amal Monobloc carburettors. The head is of aluminium and provides a compression ratio of 9 : 1, in place of the standard 7·8 : 1 ratio. A gross power output of 137 b.h.p. at 5,500 r.p.m. is claimed for this engine, whereas the normal version produces 90 b.h.p. at 4,400 r.p.m. The torque is 160 lb-ft at 3,200 r.p.m., the corresponding Zephyr figure being 123 lb-ft at 2,000 r.p.m.

The Triumph Herald models are fitted with the sturdy 948 cm³ engine previously installed in the Standard Ten and Pennant models. The version in the Herald saloon has only detail changes, and its gross power output and torque are respectively 38·5 b.h.p. at 4,500 r.p.m. and 51·2 lb-ft at 2,750 r.p.m. In the Herald coupé, however, a tuned engine is employed: it has two S.U. carburettors, in place of the single Solex instrument, and the compression ratio is raised from 8 : 1 to 8·5 : 1. Consequently, the power output has risen to 50·5 b.h.p. at 6,000 r.p.m., though the torque has fallen slightly to 50·8 lb-ft at 4,200 r.p.m.

Miscellaneous—Continental

Still further development has been applied to the Alfa Romeo Giulietta four-cylinder, 1,290 cm³ engine. In its Sprint Speciale form, this 74 × 75 mm unit has a net power output of 100 b.h.p. at 6,000 r.p.m., 10 b.h.p. more than the Sprint Veloce model. There has been no basic change to the engine, which features a five-bearing, fully balanced crankshaft and two chain-driven overhead camshafts. The increased performance comes from the use of new camshafts and twin Weber carburettors of different type. Although the size of the valves has not been increased, they are of improved materials to withstand the higher operating temperatures.

In a new and larger Borgward car is a 2,240 cm³ six-cylinder engine based on the four-cylinder Isabella TS unit. It has the same bore and stroke, of 75 mm and 84·5 mm respectively, and a generally similar layout; in both instances, the compression ratio is 8·2 : 1. An uncommon feature is that the cast aluminium rocker gear cover embodies the inlet manifold, and carries the twin-choke Solex down-draught carburettor. Removal of the cover for adjusting valve clearances is rendered unnecessary by the use of a secondary cover plate on the side of the casting The output, based on the D.I.N. standard, is 100 b.h.p. at 5,200 r.p.m. and the maximum torque is 119 lb-ft at 2,800 r.p.m. For comparison, the Isabella engine has an output of 75 b.h.p. and a torque of 84·6 lb-ft at the same speeds.

An interesting newcomer from D.K.W. is the Junior, 741 cm³ engine. This is, in effect, a scaled-down version of the 1000S 980 cm³ unit, and both are three-cylinder, two-stroke engines employing crankcase compression and conventional porting. The Junior has an equal bore and stroke of 68 mm; its cylinder head is of aluminium, and the compression ratio is 8 : 1. Mounted on the cylinder head is the generator, driven by a long V-belt from a pulley on the crankshaft. The three ignition coils are clipped to the generator, which is of the through-drive type. On the rear end of the generator shaft is the ducted, plastics fan that blows air through the radiator, installed behind the cylinder

block. The new engine has a gross power output of 39 b.h.p. at 4,400 r.p.m., and its torque is 47 lb-ft at 2,500 r.p.m. Both are satisfactorily high figures for a unit of this type.

For 1960, a tuned version is offered of the Goggomobil 688 cm³ twin-cylinder, four-stroke unit seen last year. The new engine, which is fitted to the little Fleetwing coupe, retains the 78 × 72 mm cylinder dimensions of the other. However, the compression ratio has been raised from 7·2 : 1 to the unusually high figure, for an air-cooled engine, of 9·2 : 1. Also, two Solex horizontal carburettors replace the single downdraught Solex of the standard engine. Whereas the latter produces 30 b.h.p. at 4,900 r.p.m. and has a torque of 34 lb-ft at 3,500 r.p.m., the tuned model gives the corresponding figures of 34 b.h.p. at 5,700 r.p.m. and 39·8 lb-ft at 3,500 r.p.m.

Another twin-cylinder air-cooled engine that was first seen last year is the N.S.U. Prinz. This, however, is a rear mounted in-line unit, with the 360 deg crankshaft disposed transversely, whereas the Goggomobil engine is installed at the front and has a longitudinal crankshaft. An outstanding feature of the Prinz engine is its use of a double-eccentric drive to the overhead camshaft. The standard model has been developed in minor respects, but a more powerful version is fitted to the Sport Prinz coupé and the Prinz 30 saloon. It has considerably enlarged and polished gas passages, modified valve timing to give increased overlap, and a compression ratio of 7·2 : 1, as against the standard ratio of 6·8 : 1. By virtue of these changes, the power output has been raised to 36 b.h.p. at 5,500 r.p.m. No maximum torque figure has yet been released.

The Porsche Super 90 is fitted with a development of the existing 1,582 cm³ horizontally opposed, four-cylinder air-cooled engine. A stiffer crankshaft is employed, running in lead-bronze bearings; the connecting rods, too, are more rigid. The compression ratio has been raised from 8·5 : 1 to 9 : 1. Larger carburettors, inlet ports and inlet valves are now employed and, though the camshaft is unaltered, the valve lift has been increased by moving the rocker pivots to alter the leverage ratio. Finally, the exhaust system has been modified to improve the gas flow. From the 88 b.h.p. at 5,000 r.p.m. of the Super engine, the gross power output of the Super 90 unit has been raised to 102 b.h.p. at 5,500 r.p.m. The net figure, from which the car's designation is taken, is 90 b.h.p.

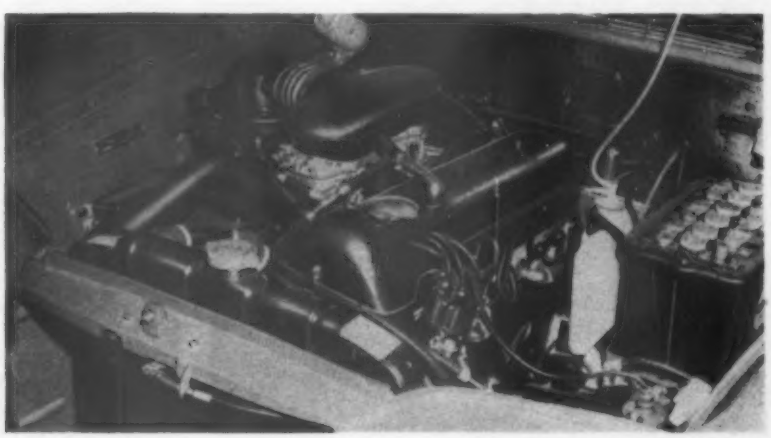
Introduced originally for the Renault Floride, the Gordini-modified engine is now available also in the Dauphine model. It retains the long-stroke 58 × 80 mm measurements of the Dauphine, but the compression ratio is raised from 7·75 : 1 to 8 : 1. Also, a rather larger Solex carburettor is fitted on an improved induction manifold, and the valve gear has been modified to withstand the higher engine speeds possible. The standard engine has a net power output of 31 b.h.p. at 4,200 r.p.m. and its maximum torque is 48·4 lb-ft at 2,000 r.p.m. For the Gordini version, the corresponding figures are 40 b.h.p. at 5,000 r.p.m. and 48 lb-ft at 3,000 r.p.m.

The only twin-cylinder two-stroke engine shown was the Goggomobil 293 cm³ air-cooled unit. It has cylinder dimensions of 58 × 56 mm.

Modifications to the Skoda 1,089 cm³ engine from Czechoslovakia have increased the gross power output from the 43 b.h.p. of the Octavia model to 53 b.h.p. in the case of the Felicia. The engine speed for maximum power has risen also from 4,600 r.p.m. to 5,600 r.p.m., and the torque has improved from 50·6 lb-ft at 2,800 r.p.m. to 54·2 lb-ft at 3,500 r.p.m. These increases have been effected by raising the compression ratio from 7 : 1 to 8·4 : 1, and by fitting two Jikov carburettors instead of one. The head shape of the valves has been modified, more heat-resistant materials are used, and thrust cups are fitted on the exhaust valve stems.

Miscellaneous—U.S.A.

As was the case last year, relatively little information was available at Earls Court regarding the American manufacturers' 1960 engines, other than those already described. In general, the existing units appear to be little changed, though there are several instances of reduced compression ratios, as indicated by the table published on an earlier page. A typical example of this trend is the 5,358 cm³ V-eight engine of the American Motor Corporation Ambassador cars. Last year, this had a compression ratio of 9·7 : 1, but for 1960 it is reduced to 8·7 : 1, although the earlier design with the higher compression ratio can still be obtained.



A feature of the Mercedes 220S 2·2-litre unit is valve actuation by a single overhead camshaft. The latest modifications include changes to the rocker layout and cam form; larger compound carburettors are fitted

Carburation and Induction

The Latest Features Include Systems for the New V-Eight Engines, Further Development of Short Downdraught Carburettors and Shallow Air Silencer and Cleaner Assemblies

IN the months preceding the previous Motor Show, a trend towards larger capacity power units was noticeable, and now this trend is even more marked. A number of motor manufacturers exhibited vehicles with engines of greater swept volume than those shown last year. From the point of view of carburation, the larger engine, with its lower peak r.p.m., and increased torque lower down the speed range, is a more satisfactory proposition than the small engine operating at high r.p.m. Carburettor, induction tract, and valve areas can be more reasonable, and, in general, sweeter carburation can be obtained under these conditions.

The problem of designing and producing short downdraught carburettors of sufficient airflow capacity has been tackled with vigour by the carburettor manufacturers and, while small difficulties remain, remarkable progress has been made. These difficulties are chiefly those of accommodation. Bonnet lines become lower, and space around the sides of the engine becomes restricted as more and more accessories are mounted inside the engine compartment, but still the carburettors and their air filters and silencers are somehow crowded into position.

Apart from the shortening of downdraught carburettors, there has been little change in either carburettors or induction schemes since last year. Petrol injection has made little progress, and it looks as if the carburettor will remain a standard feature for many years. Possibly, the most outstanding event has been the introduction by Rolls-Royce Ltd. and the Daimler Company Ltd. of their new V-eight engines, the carburation system of which will be described in detail later in this section of the review.

Four-cylinder engines

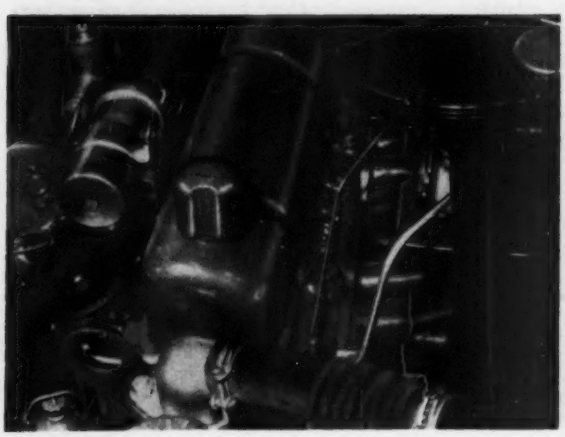
Among the more interesting exhibits were the B.M.C. ADO 15 cars—the Austin Seven and Morris Mini-Minor. Since the power unit is installed transversely across the front end, the carburettor and the induction and exhaust manifolds are at the rear of the engine. Formed integrally of a single iron casting, the induction and exhaust manifolds are joined in the middle, underneath the carburettor riser. A single S.U. HS2 horizontal carburettor, inclined at a small angle—perhaps 25 deg from the horizontal—feeds mixture to the simple two port-branch induction manifold, which, in turn, supplies the siamesed inlet valve ports. The induction tract is of circular cross section, having small-radius bends which turn inwards and fall to meet the ports in the head. A hot-spot is formed by the junction of the induction and the exhaust portions of the casting, so that the mixture is rapidly heated after a cold start.

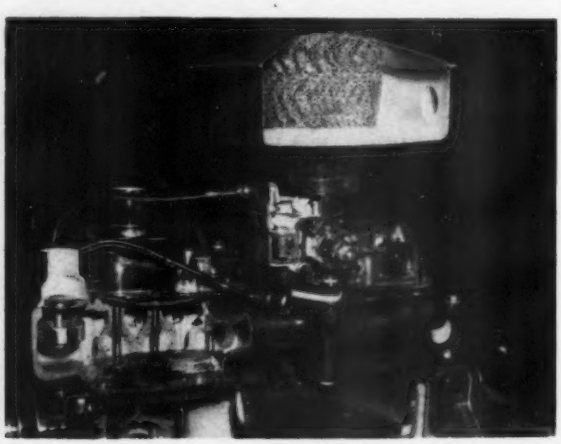
The carburettor has its float chamber on the left-hand side. As with the other versions of this new S.U. HS2 carburettor, there is no threaded union connecting the petrol pipe with the carburettor inlet: instead, the top of the float chamber carries a short tubular stub, over which is pressed a length of nylon petrol piping. Nylon tubing is also employed to connect the float chamber with the main body of the carburettor. For cold starting, the choke control on the dash is linked to a simple mechanism that lowers the jet sleeve and so enlarges the area of the jet orifice. At the same time, another link opens the throttle valve a small amount to provide the necessary amount of mixture for the cold start and subsequent warm-up.

Bolted to the carburettor air intake is a short curved aluminium casting, which connects the carburettor with the small paper element air filter and silencer. The fuel tank is installed in the left-hand side of the boot. A single S.U. electrically actuated pump is mounted under the frame, close to the tank. This pump is one of the new PD type. Like the earlier S.U. models, it is operated by means of a solenoid and make-and-break contacts. But in this instance, the energy from the pump spring is transmitted to the diaphragm through the medium of oil pressure. An interesting feature of this pump is the diaphragm material, which is transparent Terylene, only 0·015 in thick.

Although it has been in production for some months, the Triumph Herald is, nevertheless, a newcomer to the Show.

Left: A twin-gallery induction manifold is now used on the Hillman Minx, and a Zenith 30 VIG carburettor replaces the previous 30 VM8 unit. Right: On the new Ford Anglia engine, a straight-rake, inclined inlet manifold, having buffer ends, is fitted. The Solex carburettor embodies a novel economizer





This car is powered by a four-cylinder engine of 948 cm³ swept volume, similar to that of the Standard Pennant. Its induction and exhaust manifolds are on the right-hand side of the engine, and are formed integrally of cast iron, the induction manifold being the upper of the two. Since the inlet valve ports are siamesed, the induction manifold is of the conventional two port-branch form, and its tract is of circular cross section.

A Solex B28 ZIC-2 downdraught carburettor is fitted, and it feeds into the centre of the short gallery tract, which curves in towards the cylinder head at each end. From the centre of the gallery, the tract rises slightly to the port-branch bend. The exhaust manifold portion of the casting also follows conventional lines, being of the four port-branch pattern, with the two intermediate ports close together and the two outer port-branches on the extreme ends. As with the similarly integral induction and exhaust casting of the ADO 15 engine, the mixture hot-spot provides a rapid warm-up, because the heat conduction path is uninterrupted by joints and gaskets.

From a point in the centre of the induction gallery tract, below the carburettor, a small-diameter drain pipe takes away excess fuel. An air silencer of the so-called pancake type, a large but shallow circular unit, fits directly on top of the carburettor. The single fuel tank is fitted into the rear of the left-hand rear wing, and from here fuel is fed to the carburettor by means of an AC mechanical fuel pump, mounted on the left side of the engine crankcase, at the rear.

Another completely new exhibit was the Ford small overhead valve engine. This is an over-square four-cylinder unit of 997 cm³ swept volume, with a bore and stroke of 80·96 mm and 48·41 mm respectively. Both the manifolds are on the left-hand side of the engine, the induction being above the exhaust in the conventional manner. A single Solex B30 ZIC-2 downdraught carburettor supplies the cast iron inlet manifold, which has four branches at right-angles to the gallery, so forming what is commonly known as a straight-rake type manifold.

From front to rear, the porting arrangement is as follows: exhaust, inlet, inlet, exhaust, exhaust, inlet, inlet, exhaust. There is quite a sharp fall in the port-branches from the gallery to the inlet ports in the cylinder head, but to avoid excess liquid fuel reaching the cylinders, the main gallery tract rises slightly on each side of the riser. The cross sectional shape of the gallery is circular, while that of the port branches is rectangular, a conformation which is continued in the inlet valve ports in the cylinder head. An interesting feature of the induction manifold is the series of circumferential grooves in the gallery, between the port branches of cylinders 1 and 2, and of cylinders 3 and 4. These are doubtless provided as an aid to mixture distribution.

The two manifolds are bolted together beneath the riser in the usual manner, with an ingenious form of thin-plate hot-spot. The floor of the induction manifold and the ceiling of the exhaust are left open, the orifices being circular, and a Welch plug is pressed into the aperture in the floor of the induction manifold. Therefore, while the liquid fuel sprays upon the upper side of the Welch plug, the exhaust gases play upon the underside. An AC mechanical fuel pump is employed: it is installed on the right-hand side, towards the rear of the crankcase. The carburettor is surmounted by a large pan-shape air filter, having a single, silencing tube projecting towards the front.

The Solex B30 ZIC-2 downdraught carburettor incorporates a new device, known as the Econostat. With it, the suction pulsations in the induction tract of a four-cylinder engine are employed to provide a measure of part-throttle economy without the aid of mechanical valves. In addition to the usual main jet and air corrector jet, there is an extra fuel jet and an air jet, and the assembly is so arranged that these extra jets come fully into action on full-throttle only, particularly at high engine speeds. This system enables the size of the main jet to be a little smaller than with the standard arrangement, so resulting in improved part-throttle economy.

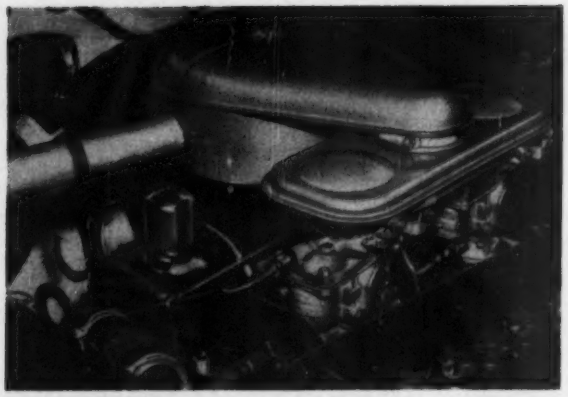
Several of the B.M.C. cars of medium size are powered by the well-tried Series B, 1,489 cm³ engine. Those of the Austin A55, the Morris Oxford and the Wolseley 15/60 are equipped with a single S.U. HS2 carburettor, while twin

The manifolding of the B.M.C. ADO 15 engine follows the company's normal practice. One iron casting comprises the inlet and the exhaust manifolds, and the S.U. HS2 carburettor has a downdraught angle

S.U. carburettor installations are employed on the Riley 4/Sixty Eight and the M.G. Magnette Mark III. On the Austin A55, the induction manifold has been redesigned to give improved flow characteristics, and now is a single casting integral with the exhaust manifold. As in previous versions of this engine, the inlet valve ports are siamesed, so the induction manifold is a simple two port-branch system. The tract is of circular cross section, and curves inwards to the head. Since the gallery tract is well above the inlet valve ports in the cylinder head, the two port-branches have a considerable drop to the valve ports. Following the popular trend, the horizontal S.U. HS2 carburettor is tilted upwards at a slight angle, in what is known as the semi-downdraught arrangement.

As hitherto, the exhaust manifold is of the three port-branch pattern, with the central branch taking the exhaust gases from cylinders 2 and 3, and with the off-take pointing downwards and to the rear. Another B.M.C. feature that has been retained is the metal-chamber fuel trap in the small-bore pipeline of the suction ignition control unit. This trap is employed to prevent liquid fuel running down from the carburettor throttle barrel into the suction chamber of the ignition distributor. It is interesting to find that it is apparently necessary even with the nearly horizontal carburettor: B.M.C. seems to be alone in fitting such a device. A paper-element air cleaner of shallow cylindrical form fits directly on to the carburettor intake, the silencing element of the cleaner being a funnel-ended tube facing towards the radiator. All versions of this basic model, including the Riley 4/Sixty Eight and the M.G. Magnette Mark III, have the fuel tank behind the rear seat squab. Also fitted at the rear, and close to the fuel tank, is one of the new S.U. PD fuel pumps.

The twin-carburettor versions of the Series B engine are equipped with S.U. HD4 carburettors. These have 1½ in diameter throttle barrels, and are larger than the single



On the latest Singer Gazelle, two Solex carburettors are fitted instead of one. Unlike most Solex instruments, these do not embody the familiar starter box but have strangler valves and linked fast idle mechanisms

carburettors fitted to the Austin, Morris Oxford and Wolseley versions. The HD4 carburettors each have a diaphragm sealing device for the jet sleeve, which replaces the cork glands and washers of the earlier designs. As on the smaller B.M.C. engine mentioned earlier, nylon tubing is used to connect the float chamber with the carburettor body. On the HD4 model, there is also a separate slow running system, which by-passes the throttle valve, after the fashion of the conventional open-choke idle arrangement. As with the single carburettor models, the fuel trap in the suction pipe is retained; in this instance, the pipe is taken from the throttle body of the rear carburettor.

The induction and exhaust manifolds are, of course, different from those of the single-carburettor engines. The carburettors are arranged in the semi-downdraught position, each being bolted to a short stub extension of the gallery tract, with a balance pipe joining the two. The three port-branch exhaust manifold carries two horizontal, machined faces, which are bolted to the undersides of the two inlet stubs, so providing a pair of efficient, exhaust heated hot-spots.

A pan-shape air cleaner is mounted above the rocker cover, and is connected to the carburettor intakes by a light alloy casting. Two forward-facing, funnel-ended tubes form the silencing elements. As on the single-carburettor models, a breather pipe connects the rocker cover with the air cleaner. The float chambers are in the space between the carburettor bodies; on top of each chamber is a banjo bolt, from which a flood drain pipe leads down to discharge below the exhaust pipe. A heat shield is placed between the exhaust manifold and the carburettors.

With the introduction of the new four-cylinder 80 model, the Rover Company Ltd. have broken away from the F-head form of combustion chamber which they have favoured for so many years. The layout of the combustion chamber and valves is described in the previous section of this review. The induction and the exhaust manifolds are both on the left-hand side of the engine, with the induction above, in the usual manner; the cast iron induction manifold has four port-branches, which are arranged in pairs. On leaving the riser, the gallery bifurcates before the branches turn in to the cylinder head. The induction tract is circular in section. A departure from previous Rover practice is the adoption of an exhaust-heated hot-spot. The junction of the riser and gallery is surrounded by a jacket, into which exhaust gases are deflected by the thermostatically controlled heat valve in the exhaust manifold, just above the off-take flange.

Fitted to the intake of the Solex B40 PA10-5 downdraught carburettor is a curved air trunk, fabricated from sheet metal. This is connected to a length of corrugated rubber hose, which, in turn, is joined to the oil-bath air cleaner, mounted on the right-hand side of the engine, towards the front. An S.U. electric fuel pump is installed in the boot.

For some years, Rootes have been producing sports saloons in their Sunbeam range. This year they have broken into the field of the true sports car, with the new Sunbeam Alpine, powered by a high-performance version of the Rootes 1,494 cm^3 four-cylinder engine. The induction and exhaust ports are on the left-hand side of the aluminium cylinder head. They are so disposed that no two exhaust ports are adjacent to one another. The induction manifold is also of cast aluminium, of approximately circular cross section and with an angle on the lower side, nearest the engine.

Zenith twin 36 WI short downdraught carburettors are employed, and are fitted between the inlet port-branches of the front and rear pairs of cylinders. A cast partition separates the two sections of the induction tract, but it incorporates a large balance orifice, the dimension of which is controlled by the casting operation. Although the exhaust manifold is on the same side, exhaust heating is not employed. Instead, the induction manifold has an integrally cast jacket along its outer and lower sides; hot coolant flows through a steel pipe from the rear of the cylinder head to the rear of the manifold casting, through the jacket and then through a similar pipe from the front of the manifold to the suction side of the coolant pump.

Beneath the induction system is the four port-branch exhaust manifold. Instead of being of cast iron, it is fabricated from steel tubing, each port-branch being about 18 in long. Obviously the system has been designed for good extraction efficiency. An interesting feature is the pairing of the branches: those from cylinders 1 and 4 sweep down to join one Y-piece, and those of cylinders 2 and 3 sweep similarly to another Y-piece, inside the first. From the single outlets at these two junctions, pipes lead downward and turn towards the rear, to join yet another Y-piece, the outlet of which leads back to the single exhaust silencer.

The carburettors are of similar pattern to those previously employed on Rapier models, except for the design of the accelerator pump mechanism. To obtain a quick acceleration pump action over a short period, the pump piston is operated by means of a cam and roller-follower. The cam is mounted on a boss die-cast on the carburettor body, and is operated by a link attached to the throttle spindle. Connected to the pump piston mechanism is a lever that carries the nylon roller-follower. The cam registers in a peripheral groove round this roller; as the throttle is opened, the cam face, which is flat, pushes the roller lever outwards, so depressing the piston. When the roller moves over the tip of the cam, there is no further movement of the piston and, therefore, no discharge.

The metering system is similar to that of the Stromberg arrangement: the main jet, which is underneath the discharge emulsion tube, ejects the fuel into the smaller venturi of the double system. There is no power enrichment device in this installation. The coupling that connects the throttles of the two carburettors is a robust universal joint, with a thin steel disc secured to the two spiders by small bolts and nuts. Each carburettor is fitted with a small, Cooper disc type air filter, of the metal wool type. The carburettors are supplied with fuel by an AC mechanical fuel pump, mounted on the right-hand side, near the front of the engine crankcase.

Another new Rootes model is the Sunbeam Rapier Mark III. Its power unit is much the same as that of the Alpine, just described, but instead of the twin filters it has an AC oil bath air cleaner system. The outlet from

this system is connected to the middle of a fabricated metal bridge piece, which feeds the intakes of the two Zenith 36 WIA downdraught carburettors. These carburettors are basically the same as those on the Sunbeam Alpine, except for the fact that power enrichment jet systems are used. This is probably because of the difference between the two air silencing systems. On the Rapier, a conventional exhaust manifold is used, instead of the fabricated arrangement of the Alpine.

A different version of the Rootes 1,494 cm^3 engine is employed in the Hillman Minx Series IIIA. Previously, the Minx had a Zenith VM8 carburettor of the static type, having neither an acceleration pump nor a power jet system. This was used in conjunction with a four port, straight-rake induction manifold. On the new Series IIIA model, the induction system has been entirely redesigned to provide more power and greater economy. This has made it possible to take full advantage of the economizer system incorporated in the Zenith 30 VIG carburettor now fitted.

The latest carburettor is similar in general design to the VM8, its main difference being the employment of an acceleration pump and economizer device. Unlike many built-in automatic economizers, the VIG arrangement does not incorporate a power jet to supply extra fuel for high power. Instead, the lean mixture for economical cruising at part-throttle is obtained by weakening the mixture. This is done by a small suction-operated disc valve, which admits more air into the emulsion system when the throttle is only partly open. During full-throttle operation, however, the air valve closes, so cutting off the extra supply of air. The disc valve plate is mounted on one side of a small flexible diaphragm; the other side is part of a sealed chamber connected, by a channel in the carburettor body, with the depression in the induction manifold. A light spring in the suction chamber holds the disc valve on its seat under full-throttle conditions. When, however, the throttle is partly open, and there is a high measure of induction depression, this depression acts upon the diaphragm and draws it outward against its spring, so opening the air valve and weakening the mixture. For cold starting, an offset mounted strangler valve of the now conventional form is used in conjunction with a mechanical linkage for opening the throttle.

The new induction system is based broadly on the twin-gallery manifold arrangement that Rootes developed some years ago for the larger Sunbeam Talbots, Marks I to III, and which was later employed on the first Rapier model. Instead of being an aluminium casting, however, the new Minx manifold is of cast iron. Like the previous examples mentioned, the downdraught carburettor delivers its mixture through a short riser into a mixture chamber immediately below it, in the manifold. From this chamber, two tracts lead off on each side. The outer tracts supply cylinders 1 and 4, the inner ones cylinders 2 and 3. Thus, the application is that of a single carburettor to the classic twin-barrel carburettor induction scheme. The galleries of both tracts turn in gentle curves towards the cylinder head inlet ports.

As in the previous Minx models, the four port-branch exhaust manifold is below that of the induction system. The four-bolt flange on top of the exhaust manifold is open, so that when the two manifolds are bolted together, the exhaust gases play directly upon the floor of the induction mixture chamber, at a point where the heat is most beneficial. From the floor of the mixture chamber, a drain pipe takes excess fuel away and discharges it below the exhaust pipe. A reinforced, asbestos heat shield is placed between the carburettor and the induction manifold. This heat shield is pierced for the throttle bore and carburettor stud holes, and, therefore, also serves as the carburettor-induction manifold gasket. Ingoing air passes through a shallow pan-shape AC air silencer and filter, which has a tapered intake tube pointing forward and down to the radiator.

Changes have also been made to the carburation system of the Singer Gazelle. On the previous model, a single Solex downdraught carburettor supplied mixture to a twin-gallery induction system similar to that already described in connection with the new Hillman Minx. On the latest Gazelle, the single downdraught carburettor is replaced by a twin downdraught installation with Solex carburettors.

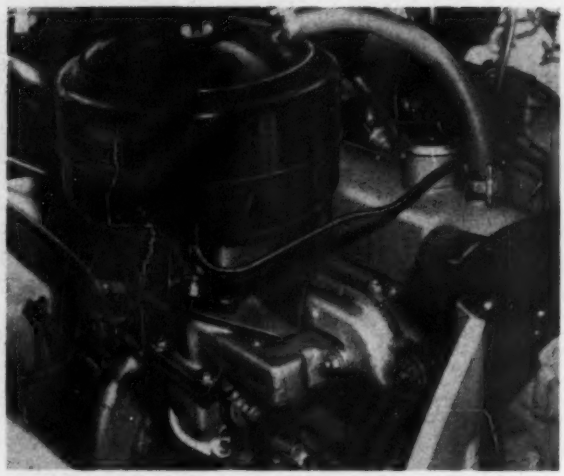
The induction arrangement is almost identical with that used on the earlier Sunbeam Rapier models. Each carburettor feeds a small bifurcated, cast aluminium, induction manifold, the front carburettor supplying mixture to cylinders 1 and 2, and the rear one cylinders 3 and 4. The tracts divide in two just below the riser and curve inwards towards the cylinder head inlet ports. A balance pipe, of about $\frac{1}{2}$ in outside diameter, connects the two risers.

As on earlier Rapier engines, the two induction manifolds are in limited contact with the exhaust manifold below, so that the amount of heat transfer is small. A thick asbestos gasket separates the induction manifolds from that of the exhaust, but each induction casting has two short legs, which are in contact with the machined upper face of the exhaust manifold. Thus, the contact area is limited to that of the three legs, which is only about $\frac{1}{2}$ in^2.

A single AC oil-bath air cleaner is fitted above the rocker cover, and the outlet is connected to the mouth of a fabricated sheet metal box, which fits over the air intake of

A Zenith 42 WIA carburettor is installed on the enlarged Humber Super Snipe engine. It is one of the short downdraught units intended to permit a low bonnet line. The manifold feeds two internal gallery tracts

Another engine to be fitted with one Zenith 42 WIA carburettor is that of the new Armstrong Siddeley Star Sapphire Limousine. The AC air filter is of the latest type, with a paper element and two silencing tubes



The 2½-litre Volga engine, from Russia, has a downdraught carburettor. Because of low winter temperatures and low-grade fuels, the exhaust hot-spot is unusually large. An adjustment is provided for the main jet; it can be seen immediately below the middle of the air filter

each carburettor. As with the other versions of this Rootes engine, the fuel pump is on the left-hand side near the front of the crankcase. A drain pipe is fitted to each induction manifold.

Twin B32 PBIS Solex carburettors are employed and they are of this company's conventional downdraught design, except in respect of the cold starting arrangement. These instruments are not fitted with the well-known Solex starter carburettor—an almost universal feature of this make—but have strangler valves. Unlike most other forms of strangler valve, these are not semi-automatic, in the sense that they cannot be opened by the airflow, although they are offset mounted in the usual manner. To provide some automatic reduction of mixture strength with increasing air flow, small spring-loaded disc valves are fitted in the strangler plates. A fast-idle interconnection linkage with the throttle spindle ensures the correct throttle opening for cold starting. Incorporated in each carburettor is an acceleration pump, of the usual Solex diaphragm design, mechanically operated by a rod connected to the throttle spindle.

A stand that attracted a lot of attention was that on which the Russian Volga and Moskvitch cars were shown. From the carburation and induction aspect, the engines of these cars are clearly designed for very cold weather operation and probably for fuel of lower volatility than that employed in the West. Both models incorporate radiator shutters in front of the radiator block, as employed by Rolls-Royce, but manually operated by cable from the dash. Also, the ignition manual control, which overrides the automatic advance, and the generous heating of the induction manifolds are both indicative of design for cold climates.

The Volga has a four-cylinder power unit of 2,445 cm³ swept volume, with a bore and stroke of 92 mm. Both the induction and the exhaust manifold are on the right-hand side, with the exhaust manifold branches arranged above those of the induction, in a manner reminiscent of commercial vehicle engine practice of twenty-five years ago. The exhaust manifold branches of cylinders 1 and 4 sweep up over the induction branches, then down between them and the cylinder head, to join the branches of cylinders 2 and 3, and thence down again to the off-take flange. A massive exhaust heated jacket surrounds the riser T-junction, the exhaust gas flow to it being regulated by a thermostatically controlled flap valve of the conventional Western pattern. Feeding siamesed inlet ports, the induction manifold is a two port-branch casting with passages of rectangular cross-section. To protect the carburettor from heat radiated from the upper exhaust manifold branches, a metal heat shield is fitted. Fuel is supplied by a mechanical pump, on the left side of the engine crankcase. A large, shallow pan-shape air filter fits directly on top of the downdraught carburettor intake.

A smaller engine is employed for the Moskvitch car. It is slightly over-square, having a bore and stroke of 76 mm and 75 mm respectively, giving a swept volume of 1,361 cm³. The induction and exhaust manifolds are on opposite sides of the cylinder head, with that of the induction system on the left. A massive, cast aluminium induction manifold, apparently of the four port-branch type, is used. It is heavily water jacketed over the whole of its visible exterior. As on the Volga, the amount of manifold heating is doubtless dictated by the rather low-grade, 72 octane fuel for which the engine is designed. The coolant thermostat housing is also incorporated in the induction casting. From it, the coolant outlet pipe is taken to the top tank of the radiator.

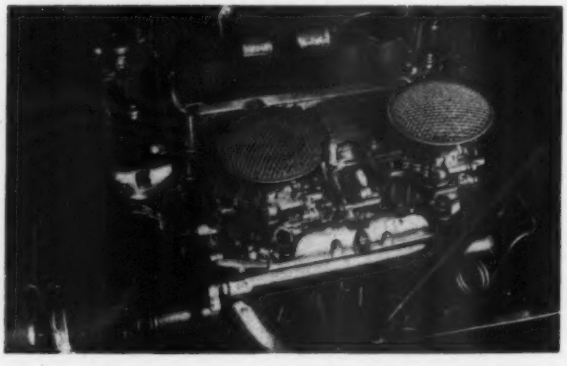
Mixture is supplied by a single-barrel, downdraught carburettor of apparently conventional design. From the air intake of the carburettor a moulded rubber hose is taken over to the large air cleaner, on the right-hand side, near the front of the engine compartment. The exhaust manifold, also on the right-hand side of the engine, is a four port-branch casting of the usual pattern. A mechanical fuel pump, on the other side, is mounted low down near the front end of the crankcase. As on the Volga, manually controlled shutters are fitted in front of the radiator block.

Six-cylinder engines

Both the Austin A99 and the Wolseley 6/99 engines, the swept volume of which has been increased to 2,912 cm³, are equipped with twin S.U. carburettors. These instruments feed an induction system very similar to that of the previous 2,639 cm³ models. They are, of course, horizontally installed, and are mounted on the left side of the engine, with their float chambers adjacent to one another.

The long, circular section induction tract is cored in the cylinder head. From the main tract, the six individual inlet ports lead down to the valves, forming a conventional straight-rake system. There is a balance hole in the restriction in the middle of the gallery tract, each carburettor supplying three cylinders. The front carburettor is between the inlet valve ports of cylinders 2 and 3, and the rear one is between those of cylinders 4 and 5. An AC air silencer is mounted on the left, towards the front of the engine compartment. This is connected to the air intakes of the

Two Zenith 36 WI carburettors are fitted to the 1½-litre engine of the new Sunbeam Alpine sports car. The jacketed inlet manifold is divided internally, but a large balance hole is incorporated in the medial wall



two carburettors by a large, cast aluminium T-piece. Fuel is supplied to the carburettors by a pair of S.U. PD type electric fuel pumps in the boot, close to the fuel tank which is behind the seat squab.

As on the earlier models, there are two exhaust manifolds, one for the front three cylinders and the other for the rear three. The off-takes of the two manifold castings are connected to a Y-piece, which channels the exhaust gases into the single exhaust pipe. A large metal heat shield is fitted outboard of the exhaust manifolds.

The carburettor throttle spindles are not coupled together directly. Instead, there is a pick-up lever arrangement by which the throttle of the rear carburettor first opens a small amount, then the pick-up opens the throttle of the front carburettor. The amount of lead in the opening of the rear throttle is, however, extremely small.

Another version of this 2,912 cm³ engine forms the power unit of the new Austin-Healey 3000, which has succeeded the Austin-Healey 100 Six with the earlier 2,639 cm³ unit. The cylinder head and induction system are different from those employed on the standard engine. On the Austin-Healey 3000 there is no internal induction gallery. Instead, the six individual inlet valve ports are fed directly by a six port-branch external induction manifold casting, of aluminium. Twin S.U. HD6, diaphragm type carburettors are mounted in the semi-downdraught position, each supplying three cylinders in the conventional manner. An orifice restriction divides the gallery tract into two, and each half has its own manifold drain pipe. In addition, each float chamber is fitted with an overflow drain pipe. To provide enrichment for cold starting, an S.U. thermostatically controlled auxiliary starting carburettor is employed. This supplies a quantity of rich mixture directly into the induction tract when the engine is cold. It is controlled by a solenoid and a thermostat switch in the coolant system.

The exhaust manifold, like that of the Austin A99 and Wolseley 6/99, is in two parts, each taking the gases from three cylinders. Flanges on the top of each exhaust manifold mate with flanges on the underside of the induction manifold, to form an efficient hot-spot. A large asbestos-lined metal shield protects the carburettors from heat radiated from the exhaust manifolds. On the air intake of each carburettor is a disc type air silencer.

There has been a complete redesign of the cylinder head of the Alvis 3-litre engine, and the induction and exhaust manifold layout is also new. Previously there was a three port-branch induction system, with three pairs of siamesed inlet valve ports, but the new head has six individual inlet valve ports, which are fed by two separate induction manifolds, each with three port-branches. Both the inlet and the induction manifold are on the left side of the engine. From the front of the engine, the order of porting is, exhaust, inlet, inlet, exhaust, inlet, exhaust, exhaust, inlet, exhaust, inlet, inlet, exhaust. Thus, the exhaust ports of cylinders 3 and 4 are adjacent.

Twin S.U. 1¾ in, diaphragm type, horizontal carburettors are employed, but they are mounted at a very small angle to the horizontal. One is sited between the inlet ports of cylinders 2 and 3, and the other between those of 4 and 5. The twin induction manifolds are of cast aluminium, with tracts of rectangular cross section, and a balance pipe connects the two. In the cylinder head, the inlet ports are also of rectangular shape at the induction face, but change to circular at the approach to the inlet valves, where a venturi effect is obtained. On this installation, the float chamber of the front carburettor faces the rear, and that of the rear carburettor faces the front.

Though unusual, the air cleaner arrangement is similar to that used on previous Alvis models. The air to each carburettor is passed through a separate Purolator air filter; each filter is a circular unit, and both are enclosed by a flat, triangular, fabricated metal container. A large-bore tube delivers air to the container from a space between the radiator and the left-hand headlamp. Ventilation for the rocker gear cover is provided by a length of rubber hose, fitted between the cover and the filter container.

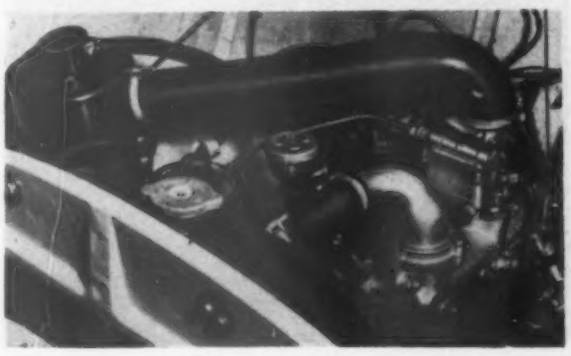
The exhaust manifolding also comprises two separate castings, arranged below those of the induction system. They, too, are of rectangular cross section, with the off-take flanges close together. A very large heat shield, of sheet aluminium, is placed between the exhaust manifolds and the air filter container, to avoid loss of volumetric efficiency. Cold starting is facilitated by the S.U. thermostatically controlled, auxiliary starting carburettor, the rich mixture from which is fed into the balance pipe between the two induction manifolds.

On the new Humber Super Snipe, the power unit is an enlarged version of the 2,651 cm³ engine introduced last year; with a bore of 87·3 mm and a stroke of 82·6 mm, the new engine has a swept volume of 2,951 cm³. Like that of the previous engine, the induction system has a double gallery arrangement, with an external six port-branch induction manifold feeding mixture into a secondary pair of induction tracts cored in the cylinder head. The layout is, in fact, similar to that of the Armstrong Siddeley Star Sapphire, except that it does not embody a balance orifice between the two secondary tracts.

Since the combustion spaces are of part-spherical form, the inlet and exhaust ports are on opposite sides of the engine, with the induction system on the right. The cast aluminium induction manifold is broadly of the straight-rake pattern, with the two end branches curving in to the inlet ports. Round the middle portion of the manifold is a jacket for coolant circulation, to provide some heat for the mixture. The coolant passes through ports in the cylinder head into the jacket, and then out through a rather small-bore pipe to the suction side of the coolant pump. Unlike most designs having a long induction gallery, this engine has a tract that follows the inclination of the crankshaft axis, which is about 2½ deg from the horizontal. A manifold drain pipe is taken from the middle of the tract, under the riser. As with most of the other Rootes engines, a non-return ball valve is fitted to the bottom of the pipe.

Mixture is supplied by a Zenith 42 WIA carburettor. This is a new unit and represents an extension of the range of short downdraught carburettors introduced a few years ago to cater for the lower bonnet line. It is similar in general design to the smaller, 36 WIA and WIP carburettors, employed for the last few years on the Humber Hawk and Sunbeam Rapier models, produced by the Rootes group.

A water heated induction manifold is a feature of the Russian Moskvitch engine, of 1·4 litres swept volume. The radiator is equipped with shutters that are opened or closed by a manual control on the facia panel



The economy system is of the power jet type, in which the lean mixture for part-throttle economy is provided by the main jet. Extra fuel for maximum power is metered by the by-pass jet, which is brought into action automatically by a spring-loaded diaphragm operated by the depression in the induction manifold. The metered fuel is fed into a double-venturi system, as with the Stromberg unit. An acceleration pump is linked to the throttle spindle, and it delivers fuel into the airstream through a pump jet, which is air-bled to relieve it of venturi suction. A follow-up spring device is incorporated on the pump piston. For cold starting, a semi-automatic strangler valve of the offset mounted type is fitted in the air intake. This is linked to a fast idle mechanism, so that the throttle opening is automatically set by the linkage for any strangler position. Following a recent trend, the float is of nylon, instead of brass or copper. A new type of AC paper-element air filter fits directly on to the air intake of the carburettor; it has two silencing tubes pointing forwards.

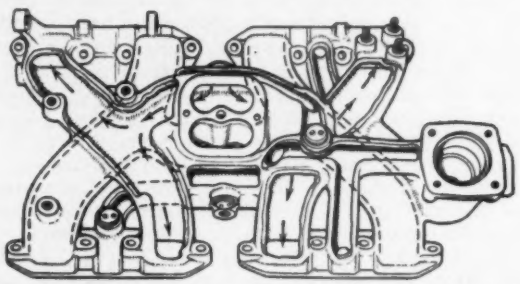
Although no alteration has been made to the induction system of the Armstrong Siddeley Star Sapphire, the carburation system has been modified. As on the Humber Super Snipe, the new Zenith 42 WIA is employed, but as a twin-carburettor installation. The main induction gallery is cored within the right-hand side of the cylinder head, and six separate inlet valve ports lead from the gallery to the inlet valves. Feeding the main gallery are twin two port-branch external induction manifolds of cast aluminium. Both manifolds are jacketed for coolant circulation. A restrictor, incorporating the balance orifice, divides the main gallery into two portions, each of which is supplied with mixture by one of the external two port-branch manifolds.

As on the previous Star Sapphire model, twin AC L-type air silencers are employed, installed transversely across the rocker cover. The exhaust manifold is constructed of two separate castings, the off-takes of which merge into a single pipe leading to the single exhaust silencer. Fuel is supplied by an AC mechanical fuel pump mounted on the right.

Exhibited for the first time was the new Armstrong Siddeley Limousine. This very large car is equipped with a single-carburettor version of the Star power unit already discussed. The carburettor, of the same 42 WIA down-draught type, feeds a four port-branch, cast aluminium induction manifold. A cylinder head common to that of the twin-carburettor model is employed, but a single induction manifold supplies mixture to the internal gallery. The new AC turret type air filter, with a paper element, fits directly on top of the carburettor intake.

Fiat exhibited one of their latest models equipped with the new six-cylinder engine. It is made in two alternative sizes, the smaller being of 1,795 cm³ swept volume. The induction and exhaust manifolds are on opposite sides of the engine, with the induction on the left. There are six separate inlet valve ports in the cylinder head, the front three being fed by a three port-branch induction manifold, while the rear three are supplied by a second manifold. These two manifolds are of circular cross section, with the port-branches leaving the gallery in smooth bends. Feeding the two manifolds is a two port-branch casting, also of circular cross section and with smooth port bends. This primary manifold bolts on to the two secondary manifolds at points between port-branches 2 and 3 of the front secondary manifold, and between port-branches 4 and 5 of the rear secondary manifold.

This complicated induction system is supplied with mixture by a Weber 34-DAS, short twin-barrel, down-draught carburettor. One throttle barrel feeds the front branch of the primary manifold, and, therefore, cylinders 1, 2 and 3, while the other throttle barrel feeds the rear branch, and cylinders 4, 5 and 6. The two throttle barrels are arranged transversely side by side, so the two independent throttle spindles are parallel to the crankshaft and are geared together without any compounding device. A coolant jacket surrounds the junction between the riser and gallery, and all three manifold castings are in a horizontal plane, from the gallery of the primary manifold to the cylinder head ports.

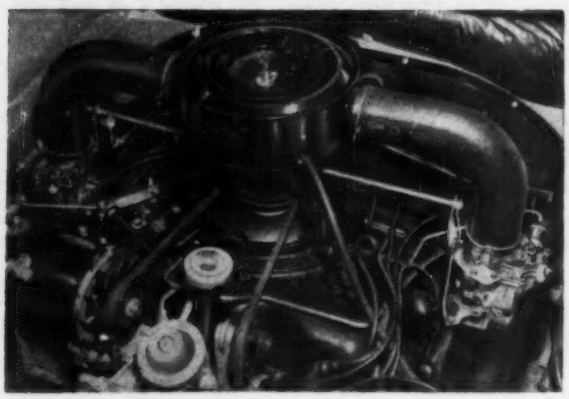


The induction manifold of the Rolls-Royce V-eight engine comprises two separate systems, each fed by an S.U. horizontal carburettor. An orthodox tract layout is used and each riser has a cored coolant jacket

The carburettor has a double venturi system in each barrel, and incorporates an acceleration pump and economizer devices. It is also equipped with an automatic choke of the starter valve pattern, operated by a coiled bi-metal thermostat spring in the conventional manner. It is operated by hot air, drawn through a small-bore metal pipe, which is taken diagonally right through the exhaust manifold at a point just above the exhaust manifold off-take. An interesting feature of the design is that the lower, or intake, end of the hot air pipe is open, where it protrudes through the exhaust manifold casting, instead of being taken into the air filter as on some modern designs. This portion of the pipe is of metal, but the greater portion, leading to the carburettor, is of a reinforced plastics material, presumably a good heat insulator.

Fitting directly on to the air intake of the carburettor is a large shallow air filter casing of elongated oval form, containing a filter unit of the paper-element type. The intake of the filter is a tube which forms a T-junction with another pipe, the forward end of which is the cool air intake, while the other end turns downwards to fit loosely over the rear of the exhaust manifold, and so becomes the warm air intake. In the T-junction is a flap valve, controlled by an external lever so that, in cold weather, warm air can be taken from the region of the exhaust manifold and, in hot

Rubber hoses connect the air filter of the Chevrolet Corvair to the two conventional downdraught carburettors. In the filter intake is a strangler with thermostatic control. The inlet manifolds are integral with the heads



weather, cool air from the front end. It is surprising that this system is not more widely employed with coolant heated induction systems, because of the advantage that it undoubtedly confers for starting away from rest with the engine cold.

The exhaust manifold is on the right-hand side of the power unit, and is a six port-branch casting of orthodox design. Its off-take is in the middle, and it has downswept port-branches of circular cross section. Fuel is supplied to the carburettor from the tank at the rear by a mechanical fuel pump installed on the left side of the crankcase.

American compact cars

Quite the most revolutionary power unit among the new models exhibited is that of the General Motors Corvair. It is mounted at the rear of the car and is an air-cooled, horizontally opposed, six-cylinder engine, of 2,296 cm³ swept volume, with a bore and stroke of 85·7 mm and 66 mm. Each cylinder of this engine has its induction manifold formed integrally on the upper side of the head casting. The induction tracts are of rectangular cross section, with a separate port-branch to each inlet valve. Two Rochester short downdraught carburettors are employed, one for each bank of three cylinders. As viewed from the rear of the car, the carburettor for the right-hand bank is between the induction port-branches of the front two cylinders, but on the left-hand bank, the carburettor is between the port-branches of the rear two cylinders of this engine.

A circular, pan-shape, paper-element air cleaner is mounted above the centre of the crankcase, and a trunk leads from the intake of each carburettor to openings in the side of the cleaner. An interesting feature is the large single strangler valve in the cleaner intake. This valve thus regulates the starting mixture for both carburettors. In conformity with general American practice, the strangler valve is thermostatically controlled.

The exhaust ports are on the underside of the cylinder heads and, of course, are separate ducts. Short steel tubes are pressed into the exhaust ports in the head castings, and to these tubes are connected the exhaust manifolds. A mechanical fuel pump supplies the carburettors from the 11 U.S. gallon petrol tank between the front suspension assembly and the toe-board.

While the Chevrolet Corvair power unit is distinctly unconventional, that of another American compact car, the Ford Falcon, follows more orthodox lines. This over-square, six-cylinder engine of 2,360 cm³ swept volume has an induction system of the straight-rake pattern, on the right-hand side. A centrally mounted, short downdraught carburettor feeds the cast iron main gallery tract. This tract is of circular cross section, but with a groove along it on the outer side. The six port-branches, also circular in section, are short, and drop slightly towards the cylinder head. From the T-junction, the gallery tracts rise a little; this is a good feature for operation under cold starting conditions. Unlike those on most exhibits from the U.S.A., the exhaust heated hot-spot is not thermostatically controlled: instead, the exhaust manifold, which is below the induction manifold, forms a large contact-heated area where the two castings are bolted together just below the carburettor. Fuel is supplied to the carburettor by a large combined mechanical fuel pump and suction pump for the screen wiper. Surmounting the Holley downdraught carburettor, and partly enveloping it, is a paper-element air filter, encased in a metal dish-shape container of large dimensions.

An engine which incorporates a number of unusual features is that of the Plymouth Valiant. This car did not arrive at the Show until the second week, and little technical

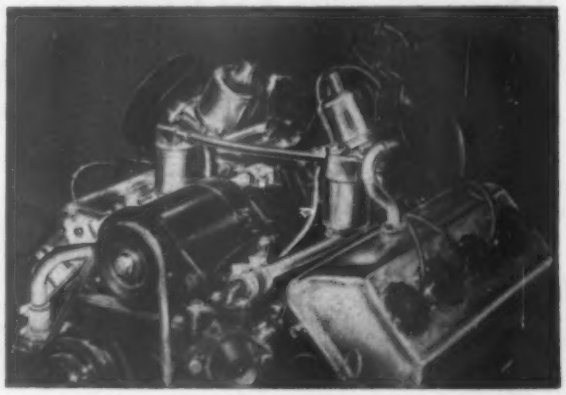
On the Fiat 1,795 cm³ engine, introduced earlier this year, an unusually complicated induction system is employed. The Weber, two-choke carburettor feeds into a two port-branch primary manifold, which in turn supplies mixture to two secondary, three port-branch manifolds; one of the latter serves the induction ports of the front three cylinders of the engine and the other supplies those of the rear three

information was available on this new model. While the 2,782 cm³, six-cylinder engine is of conventional design, it is inclined at an angle of 30 deg to the vertical, towards the right. The induction and exhaust manifolds are both on the left side of the engine. This arrangement permits the use of an induction system in which a single downdraught carburettor feeds six long separate port-branches, which radiate fan-wise from the riser T-junction beneath the carburettor.

Called the SonoRamic induction system, this arrangement is claimed to increase the cylinder filling and so improve the middle range torque. The port-branches, although long, are not of equal length: the outer ones, feeding cylinders 1 and 6, are the longest, perhaps some 10 in in length from carburettor to inlet port in the head. Those branches feeding the centre pair of cylinders are, of course, much shorter. All the tracts are rectangular in cross section.

Arranged underneath the inlet manifolding is the six-port exhaust manifold, the branches of which exhaust into a central off-take, in which a thermostatically controlled heat valve of the usual pattern is located. In this instance, the riser T-junction of the induction is not jacketed for exhaust gas from the heat valve. Instead, the underside of the induction manifold floor beneath the carburettor is finned. Exhaust gas directed by the heat valve plays upon the fins

Two S.U. semi-downdraught carburettors are fitted to the Daimler V-eight engines. The tract layout follows current U.S.A. practice: each carburettor supplies two cylinders in each bank, and the passages are of about equal length. This illustration shows the 2½-litre unit of the SP250 sports car; the 4½-litre version is fitted to the Majestic Major



when the engine is cold, and so heats the mixture. A new type of thermostat is employed on the automatic choke. Rather reminiscent of the exhaust-mounted thermostat of twenty years ago, this small unit is separate from the carburettor installation and it operates the strangler valve through the medium of a rod.

V-eight engines

With the recent announcement of the Rolls-Royce Phantom V, rumour has now become a reality, and the new V-eight engine was one of the centres of interest at the Show. It is large by any standards, with a swept volume of 6,230 cm³, and it replaces the six-cylinder unit, which had a swept volume of 4,887 cm³. The new engine has two banks of four cylinders set at 90 deg to each other. Following conventional V-eight practice, the induction system consists of a complicated casting that contains all the induction passages, and, in this instance, the various coolant channels also. This casting is between the cylinder banks.

Mixture is supplied by a pair of S.U. HD6 diaphragm type horizontal carburettors, mounted side by side. The float chamber of the left-hand carburettor is to the front, and that of the other is to the rear. Each float chamber is fitted with a drain pipe. Both carburettors have vertical flange faces, which are bolted to intake flanges on a small aluminium feeder casting. The two inlet ducts in this casting turn vertically downwards from the horizontal line of the carburettor passages; thus, each carburettor feeds into a right-angle duct, and thence into its individual tract in the main aluminium casting. The arrangement of the tracts inside the casting is, in general, similar to the scheme commonly employed on American V-eight engines with twin-barrel downdraught carburettors, even though in this instance the downdraught carburettor is replaced by the twin-tract feeder casting and horizontal carburettors. On the induction casting, the horizontal flange face to which the feeder casting is bolted contains two orifices, which mate with those in the feeder.

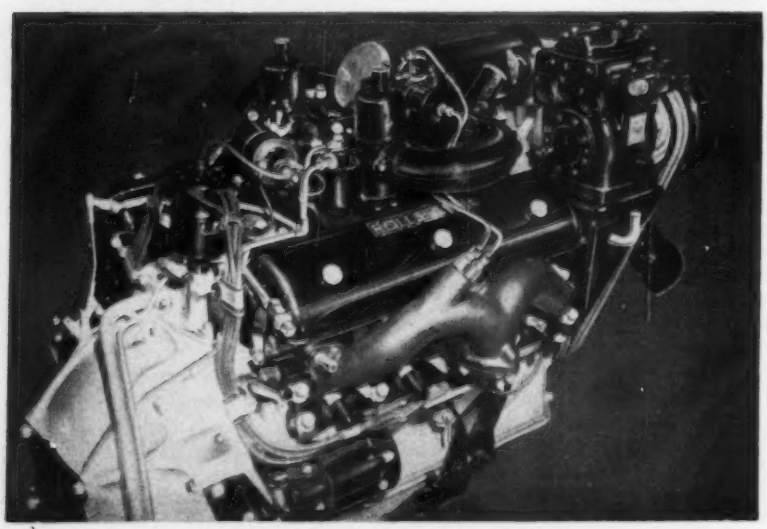
The left-hand carburettor supplies mixture through the upper set of tracts to cylinders 1 and 4 of the left bank, and 2 and 3 of the right bank. Through the lower set of tracts, supplied by the right-hand carburettor, cylinders 1 and 4 of the right bank and 2 and 3 of the left bank are supplied. This means that, as in all V-eight schemes of this nature, the riser length for the upper set of tracts is shorter than that for the lower set.

Also contained in the induction casting are various coolant passages. These take coolant from each bank of cylinders, and pass it through a jacket surrounding the two riser T-junctions, whence it flows out through the coolant thermostat housing. This housing is a pocket cored in the induction manifold, to which is bolted the outlet pipe to the top of the radiator. The induction tracts have a rectangular cross section, and mate with the individual inlet valve ports on the inner sides of the two cylinder heads. A noticeable feature of the inlet valve ports is their considerable length.

Each exhaust manifold is of four port-branch design. The off-take pipe from the right bank of cylinders is taken across to the left-hand side, where both pipes join a common silencer system, in which are incorporated three silencers. Two of these are designed to silence the low-frequency noises, while the third is to absorb the troublesome high frequencies.

A very long, flat air silencer and cleaner unit lies along the top of the engine. This is coupled by a flexible hose to a metal Y-piece, the ends of which curve round and are connected to the intakes of the two carburettors. To give access to the engine, the air cleaner and its trunking can be temporarily swung upward, on hinges, to the underside of the open bonnet; this is an ingenious and practical arrangement. Fitted in the leg of the Y-piece is a large-diameter offset mounted strangler valve. This valve is actuated by a hot-air thermostat control of conventional design, with a vacuum-kick diaphragm to open the strangler valve when the engine fires from cold. A solenoid device holds the strangler closed during cranking; this is a feature retained from the earlier Rolls-Royce Silver Wraith and the Bentley models.

Another new V-eight model exhibited at Earls Court for the first time is the Daimler SP250. With a swept volume of 2,548 cm³, it is much smaller than the Rolls-Royce power unit. As on most other V-eight engines, the induction system of this engine is a single casting, with the tracts crossing under and over one another. Two S.U. HD6 horizontal carburettors are employed, but they are mounted in a tilted position, at about 30 deg from the horizontal, transversely opposite one another. They are bolted to what are in effect two inclined risers, the channels of which curve downwards to meet the induction gallery tracts. This riser portion is an integral part of the manifold. The cross-over tracts are so arranged that one carburettor feeds two cylinders on one bank and two cylinders on the other. In this instance, the right-hand carburettor supplies cylinders 1



This view of the Rolls-Royce V-eight engine shows the horizontal mounting of the two S.U. carburettors. Heated gas is supplied through the two pipes from the exhaust manifold to the thermostatically controlled choke fitted in the intake of the C-shape trunking that connects the carburettors

and 4 on the right-hand bank and 2 and 3 on the left-hand bank. The lower tract, fed by the left-hand carburettor, leads to cylinders 1 and 4 on the left-hand bank and cylinders 2 and 3 on the right-hand bank.

A coolant heated jacket surrounds the central portion of the manifold, where the two curved risers meet the main galleries. In both the Rolls-Royce and Daimler induction systems there is a slight fall in the galleries between the risers and the inlet valve ports, but this fall is rather more marked in the case of the Daimler engine. Each carburettor has a small disc type air silencer, and a breather pipe is taken from each rocker cover to the air silencer on the same side.

On the outside of the banks, the exhaust ports curve downwards to mate with the four port-branch exhaust manifolds; these manifolds are of circular cross-section, with the off-take in the middle. The exhaust down-pipes lead to two separate silencing systems but, to damp out any objectionable exhaust beat, a balance pipe is fitted between the two systems. Fuel is supplied to the carburettors by a heavy-duty S.U. electric fuel pump, mounted on the left of the fuel tank, which is above the back axle.

Also exhibited was the Daimler eve-of-the-Show surprise, the Majestic Major. This car is powered by a larger V-eight engine, with a swept volume of 4,561 cm³, of similar design to the engine already mentioned. In this instance, two S.U. HD8 carburettors are employed, which, as on the more sporting version, are fitted in an inclined position.

CLUTCHES

New Units and Further Developments of Earlier Ones to Meet Future Requirements in Respect of High-Speed Engines

By far the largest number of cars in this country are fitted with orthodox clutches and gearboxes, and hydraulic clutch actuation is now almost universal. The fate that befell the two-pedal control systems evolved and marketed by the principal clutch manufacturers is to be lamented. However, the Saxomat FL type automatic clutch unit, produced by Fichtel and Sachs A.G., Schweinfurt, enjoys remarkable popularity in Germany and, indeed, on the Continent in general. For instance, it is reported that 20 per cent of the Auto Union G.m.b.H. output of D.K.W. cars is equipped with the Saxomat system, and other German, Swedish and Italian manufacturers are offering it with their cars. Possibly, because the traffic in or near the larger Continental cities is less dense than here, this type of transmission is more acceptable, or perhaps the Saxomat is better suited for use on *Autobahnen* and special motorways.

Clutch manufacturers appear to be aware of the considerable engine developments that are imminent, and they are preparing to meet the requirements of the near future by making refinements to existing designs, and offering clutches suitable for engines operating at higher speeds than hitherto. For instance, the Borg and Beck Co. Ltd., of Leamington Spa, will soon offer two new clutch assemblies; one unit, designated 8AS, which is basically similar to the present production 8A6 model, incorporates the strap-drive principle between the cover and pressure plate. With this arrangement, which has been thoroughly proved on much larger, commercial vehicle clutches, the pressure plate is always accurately centred and located, furthermore, a separate spider plate supports the toggle levers, thus relieving the cover of centrifugal stresses and strains and eliminating internal friction during clutch operation. Hence the 8AS type clutch will be smoother to operate and make a further contribution to reduce transmission vibrations and noise.

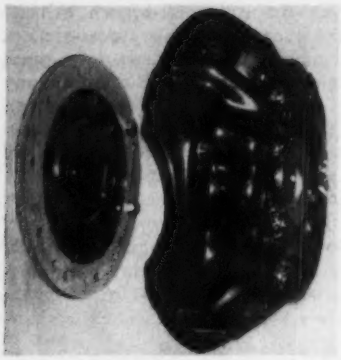
Looking still further into the future, Borg and Beck are developing their 7¼ in diameter, triple, twin and single plate, diaphragm-spring type clutches. As the name suggests, the helical springs are replaced by a large conical plate-spring, similar to a Belleville washer, giving a delightfully compact unit in which every component is accurately located; the clutch is, therefore, suitable for engine speeds of up to 12,000 r.p.m. Speeds of this magnitude were, of course, the exception, even in the motor racing world, only a few years ago. Originally, the 1½-litre, sixteen-cylinder B.R.M. normally operated up to this speed, although it had been designed to run up to 16,000 r.p.m.

At present, the torque capacity of each plate of this new

Borg and Beck exhibited this multi-plate clutch for sports and racing cars. A Belleville type spring and bronze friction facings are employed

clutch is about 90 lb-ft, and the sintered bronze friction facings make the unit much less susceptible to slipping should oil find its way in. One reason, apart from a desire to achieve greater compactness, for adopting this conical-plate spring is that helical springs tends to bow at high speed and may thus reduce the torque capacity of the clutch; since this new spring eliminates this danger, higher speeds become practicable. It is freely admitted that the new 7¼ in

A feature of this Newton and Bennett clutch plate is the damping washer between the spider and hub, visible on the cut-away plate on the left



Interchangeable with the present Borg and Beck 8A6 clutch, the new 8AS unit embodies a strap drive between the pressure plate and the cover pressing. It is suitable for speeds up to 7,000 r.p.m.

diameter clutches will, in the first instance, be applied to racing cars, but there is reason to expect that other users will adopt it in the not very distant future. Motor racing thus will have made yet another modest contribution to the general art of automobile design and development.

Newly entering the clutch design and manufacturing field, Newton and Bennett Ltd., of Acton, London, W.3, are introducing a new spring-centre damping device. In fact, their aim is at neutralizing periodic torsional vibrations, which may occur in ordinary resilient clutch-plate centres and can even be audible. A flat, spider spring-plate is riveted to the clutch plate and presses a friction washer against the hub of the centre plate of the clutch: thus, any relative movement between the clutch plate and hub, permitted by the normal cushion drive springs, is friction damped. This is a truly simple device which, because the spider spring is only very lightly stressed, should function satisfactorily for the life of the clutch plate.

A subject of controversy is whether the clutch or the transmission benefits most from a cushion drive clutch plate. However, there is, fortunately, no doubt at all that a certain amount of torsional resilience in a transmission line is beneficial and even necessary. On short transmission lines, such as on front wheel drive or rear-engine rear wheel drive cars, other means have so far been used to supplement the flexibility provided by resilient clutch centres. Examples are the Austin Seven, Morris Mini-Minor, Panhard and Fiat 600.

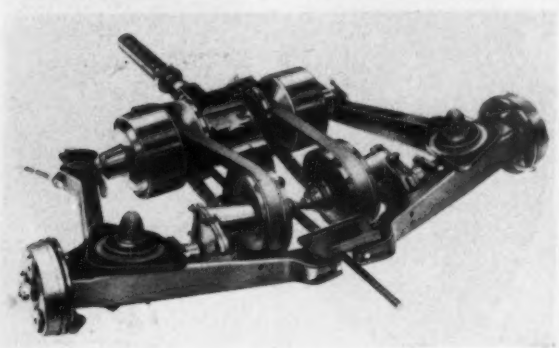
Van Doorne's Automobielfabriek N.V., of Eindhoven, have now given further details of the automatic, two-stage centrifugal clutch that they manufacture for the DAF car. When the car starts from rest, the primary segments engage with the drum at 1,100 r.p.m., and remain engaged until the engine speed falls below this figure and the return springs overcome the effect of centrifugal force. The secondary shoes engage at 2,200 r.p.m. so that both sets are fully engaged at 2,400 r.p.m., the speed at which the engine develops its maximum torque. This, undoubtedly, is the simplest way to obtain automaticity and two-pedal control.

Transmissions

Trend Towards Synchromesh on All Forward Ratios; Further Development of Automatic Transmissions

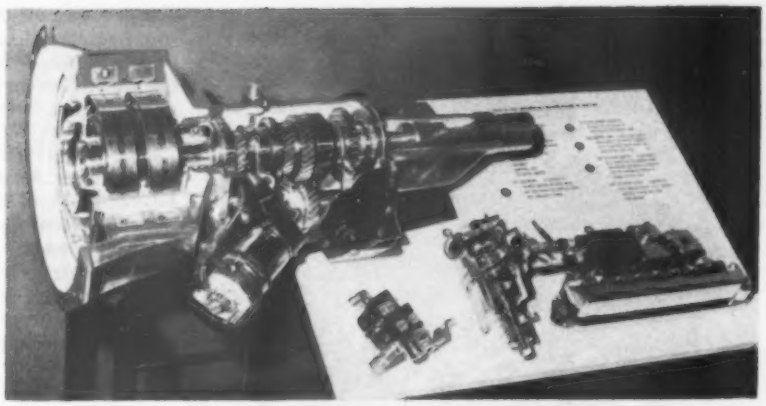
SINCE last year's Show, automatic transmissions have not made as much progress as might have been expected, although Borg-Warner Ltd. have made great strides and consolidated their position over here. S. Smith and Sons (England) Ltd. have achieved a notable success. In a relatively short time, they have developed up to full production standard their fully automatic, three-speed Easidrive transmission, which is now offered as an optional extra for the 1½-litre Hillman Minx Series IIIA and the Singer Gazelle cars. This system, formerly known as the Autoselectric transmission, has been altered in only minor details according to the dictates of production requirements and this particular installation. It is gratifying to note that British engineers have developed in such a short space of time this electro-magnetic powder type transmission suitable for any size of car, and that it is actually in production now.

Only minor changes have been made to the ingenious Variomatic belt drive of the DAF car: for example, the pulleys are of modified design



Van Doorne's Automobielfabriek N.V., Eindhoven, the producers of the DAF car, have placed their transmission at the back—an arrangement that is generally associated with much more expensive vehicles, such as Lancia, Aston Martin, and certain Lotus cars. The latter transmissions are, perhaps, far more compact, but the DAF Variomatic drive is deserving of attention, because it provides a novel fully automatic transmission system for a small car with a twin-cylinder engine of merely 590 cm^3 swept volume, developing only 22 b.h.p. at 4,000 r.p.m. For this class of car and engine, price and transmission efficiency are, of course, of far greater importance than for Chevrolet, Chrysler, American Ford or larger cars which are normally available with this refinement.

It may be recalled that the Variomatic transmission, described in the 1958 Show Review issue of *Automobile Engineer*, consists of an automatic, two-stage clutch, a power-divider, two sets of automatically variable V-pulleys and a final drive reduction to each half-shaft. By comparing last year's illustration with the present production version of the Variomatic, it can be seen that, at least so far as the transmission is concerned, the changes and modifications introduced were mainly aimed at easing production problems rather than introducing basic improvements. Detail information about the spring-loaded driven pulley, which is, therefore, highly sensitive to belt pull or torque, is still lacking, but it is stated that these pulleys are so sensitive to torque that they can adjust themselves to the driving conditions prevailing whilst cornering or turning, and it is,



In the Smiths automatic transmission are two magnetic powder couplings in tandem and a three-speed gearbox. Intermediate gear is engaged and disengaged by the solenoid, projecting from the casing

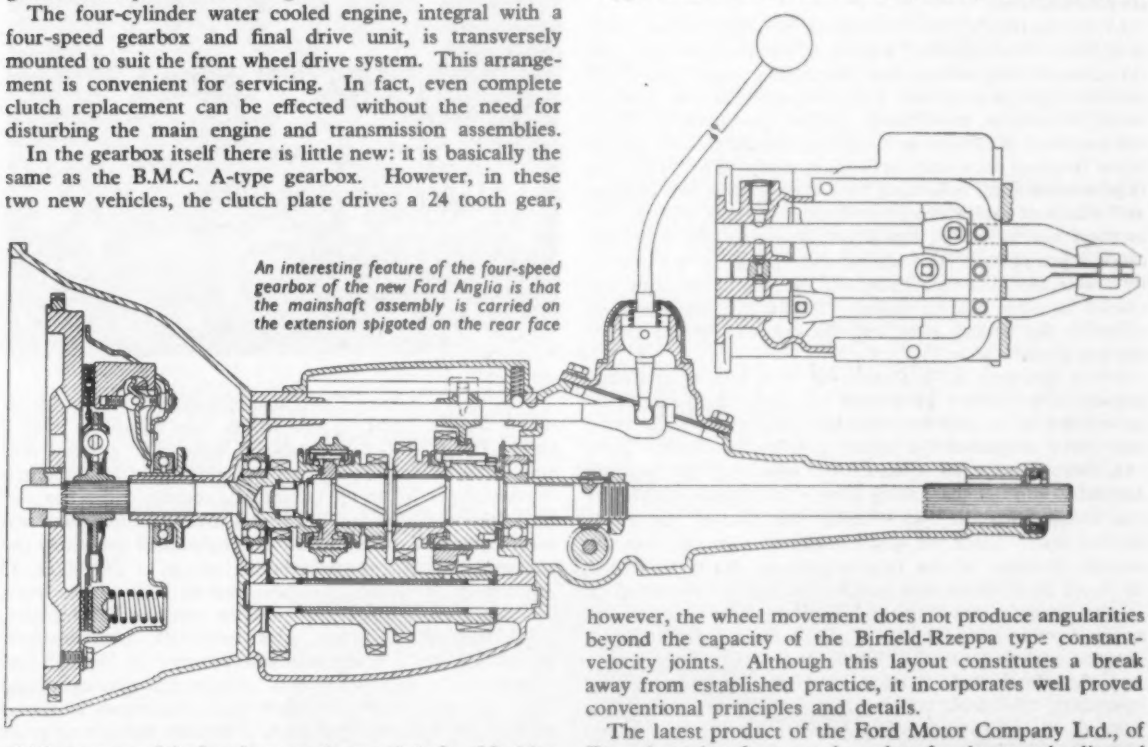
therefore, unnecessary to incorporate a conventional differential.

When one of the largest motor car manufacturers in this country introduces a new gearbox it is reasonable to expect them to show evidence of progress. However, in large production, economic considerations, available production facilities and already proven reliability carry far more weight than most design engineers would wish. The B.M.C.'s Austin Seven and Morris Mini-Minor transmission appears to be an example of this expediency, though this does not detract from the novelty and ingenuity of the general conception of the design.

The four-cylinder water cooled engine, integral with a four-speed gearbox and final drive unit, is transversely mounted to suit the front wheel drive system. This arrangement is convenient for servicing. In fact, even complete clutch replacement can be effected without the need for disturbing the main engine and transmission assemblies.

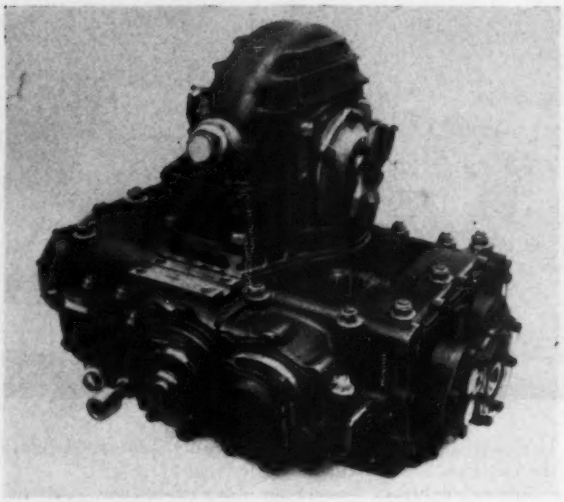
In the gearbox itself there is little new: it is basically the same as the B.M.C. A-type gearbox. However, in these two new vehicles, the clutch plate drives a 24 tooth gear, which runs on plain bearings on the crankshaft. Meshing with this gear is a 31 tooth idler which, in turn, drives a 24 tooth gear on the gearbox input shaft. This gear train is needed in order to provide sufficient clearance between the crankshaft and connecting rods and the transmission gears, but it increases unavoidably the inertia of the rotating mass with which the constant-load type synchronizing mechanism must cope during every gear change. Undoubtedly these factors were carefully scrutinized before the design was released for production.

Engine oil, from a common sump, lubricates both the engine and the gearbox. No undue problems should arise in this connection, provided the oil is changed as recommended. An advantage of this design is that it facilitates pressure lubrication of the gears on the lay and third-motion shafts, a feature which may be much appreciated in Africa, Australia and other export markets where cars have to run under extremely trying conditions. Since the gearbox and final drive form one unit, it is, perhaps, permissible to suggest that the inboard universal joints are rather far apart; however, the wheel movement does not produce angularities beyond the capacity of the Birfield-Rzeppa type constant-velocity joints. Although this layout constitutes a break away from established practice, it incorporates well proved conventional principles and details.



An interesting feature of the four-speed gearbox of the new Ford Anglia is that the mainshaft assembly is carried on the extension spigoted on the rear face

The latest product of the Ford Motor Company Ltd., of Dagenham, is a four-speed gearbox for the new Anglia and Prefect models. In detail, this gearbox is strictly conventional. It incorporates a crash type first gear, and synchromesh is confined to the upper three gear ratios. In this connection it is interesting to note that of fifteen cars in the same class, only four have crash type first gear, eleven have constant mesh bottom gear, and four makes of car have synchromesh on all forward gears. It is true that first



Above: The exterior of the David Brown C.G.537 five-speed gearbox fitted to the Aston Martin DBR 1/300. Right: In this view, the bevel input and spur output gears can be seen, also the splitting of the casing

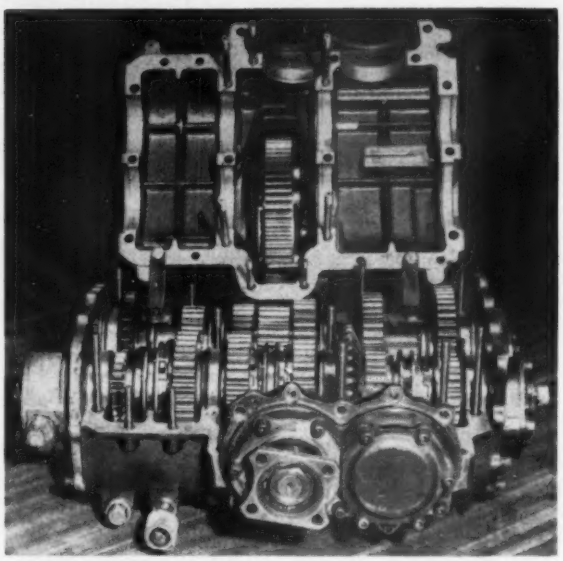
gear may be regarded as an extra-low ratio, for limited use under average driving conditions prevailing in this country, but it is a most convenient feature when driving under near traffic jam conditions or for motoring in mountainous countries abroad.

In its essentials, the four-speed gearbox follows well established Ford practice; indeed, it would appear that the synchromesh components are common to some other Ford models. All the gears are helical except first and reverse, which, of course, must have straight spur teeth to allow engagement. A one-piece layshaft is carried on two needle roller bearings on a stationary plain shaft. The 24 in long third-motion shaft is located by a deep-groove ball bearing at the back of the gearbox. At its forward end, it is carried in short needle rollers, which are housed in the constant-mesh, input pinion. The second and third gears are located by a shoulder, between them, on the shaft, and they are carried on plain bearing bushes. Similarly, a plain bearing supports the sliding joint and the tail end of the third-motion shaft.

Three bearings on a shaft, even if a long one, always present a problem. However, the Ford engineers have solved this in an attractive manner and, at the same time, they have simplified the whole gearbox assembly. Both objectives have been attained by spigoting the gearbox extension into the gear casing itself. This spigot also forms the housing for the ball bearing that locates the third-motion shaft. Since the spigot diameter is greater than the overall diameter of the largest gear on the third-motion shaft, all the third-motion components can be assembled on to the gearbox extension and finally passed through the spigot bore in the rear face of the gearbox. Alignment is assured within acceptable limits, because the spigot bore and the clutch-shaft bearing bore are machined in one operation; reasonable concentricity between the spigot and bore of the housing for this location bearing is also not difficult to achieve; and both the location and the tail end bearings are housed within the gearbox extension. A simple and neat solution of this kind indicates close co-operation between the engineering and production departments.

The gear ratios seem to have been well chosen. However, while 22 and 28 teeth for the second-speed pinion and gear are acceptable, the choice of 28 and 21 teeth respectively for the third-speed pinion and gear is, perhaps, open to question. In all other respects, this is an excellent four-speed gearbox design.

Even though the new American compact car, the Chevrolet Corvair, must be considered as an orthodox rear-engine layout, it represents a major departure from established practice so far as the large manufacturers of the United States are concerned. The principles underlying the arrangement of engine, clutch, final drive and transmission may not be novel, nevertheless there are so many attractive detail features that the design must be considered as above average. At least for the time being, the Corvair will be available here only with the automatic transmission, but in America it is also to be sold with a three-speed synchromesh type gearbox, directly derived from the Chevrolet manually controlled transmission. It is disappointing that, at the time of writing, there is insufficient information available to describe adequately the manual arrangement. If the control mechanism of the automatic transmission is as simple as it appears to be, it represents yet another example of the great strides that are being made in America to improve and simplify automatic transmissions.



This year's Sports Car Championship was won by an Aston Martin DBR 1/300, which was equipped with a David Brown C.G.537 combined five-speed gearbox and final drive unit. Requirements in respect of car handling characteristics led to the choice of a combined gearbox and final drive arrangement, but it was the desire for quick and easy changes of overall ratios that influenced decisively the configuration of this unorthodox design. The C.G.537 gearbox is, of course, not new, but in view of this car's success, it is opportune to examine some of the features.

Basically, the gearbox is a two-shaft, constant-mesh design, the shafts being arranged horizontally, beneath and parallel to the axle centre-line. All the gear-change sliding couplings are on the foremost shaft, on which is also a straight-tooth input bevel gear. The first and second gears are to the right of this bevel, and third, fourth and fifth are to the left of it; the bevel input pinion is in the same plane as the two shafts and is driven through a pair of single-helical gears. There are no sliding couplings or sleeves on the second, or output, shaft, but in the centre is the output pinion with straight spur teeth, similar to all the other speed change gears. The final drive and differential unit is mounted on top of the gearbox, so that the gear meshes

conveniently with the final drive pinion immediately below it.

Overall ratios can be quickly changed in either of two ways. One is by fitting different helical input gears; but by the alternative method, vastly different overall ratios can be obtained by fitting a different final drive gear to the differential and adjusting the centre-distance of the shafts by inserting suitable sandwich-pieces between the upper main gear casing and the final drive housing. Of course, in this way it is only possible to change the overall ratios; variations of individual ratios to provide, for instance, a different overdrive on the first gear ratio are not possible.

A noteworthy feature is that dog clutches with rather shallow face-dogs are used for the engagement of every gear, and alternate dogs on the gears and coupling sleeves are shortened to facilitate engagement. Also, the driving faces are slightly undercut to prevent involuntary jumping out of engagement. Reverse is, by force of circumstances, a crash type gear.

Equally significant is the advanced lubrication system. Gear type scavenge and pressure pumps are mounted on the right- and left-hand sides respectively, and are driven directly by the layshaft. The pressure pump feeds oil through the hollow layshaft to all the gears that idle on it when not selected. Jets on the selector shaft ensure that oil is directly sprayed only on to the gears that are engaged. This certainly is a basically sound design, with ample evidence that meticulous attention has been paid to every detail.

B.M.C. have yet another transmission innovation, on their Wolseley 6/99 and Austin A99, 3-litre cars. These are offered with either the well proved Borg-Warner automatic transmission or with their new B.M.C. three-speed constant mesh gearbox in combination with the Borg-Warner overdrive. Although, with the mechanical gearbox, these cars have six speed ratios, only five are useful, since overdrive is not practicable in first gear.

This new gearbox is of straightforward design, but is unusual because all gears, including reverse, are always in mesh. For this latter feature there is only a marginal penalty to be paid in respect of greater overall length of gearbox. The working parts of the synchronizing mechanism are remarkably effective and robust: apparently they are of equal size for all three forward gears. The principal components of each are: a spring steel synchronizing ring; an anchor block; a thrust block; and a brake band.

To engage a gear, the appropriate coupling sleeve is moved until its internal teeth tend to compress the synchronizing ring, which is thus forced to rotate. At the same time, the thrust block is pressed against the brake band, and this expands slightly and thereby increases the synchronizing effect. When synchronization is achieved, the spring pressure on the thrust block declines sharply and the coupling sleeve can then slide into full engagement.

For silence, all the gears are of the single-helical type, and those on the third-motion shaft are carried on long needle rollers, as also is the one-piece layshaft gear cluster. The general conception of this gearbox seems to be well suited to a steering column gear-change mechanism.

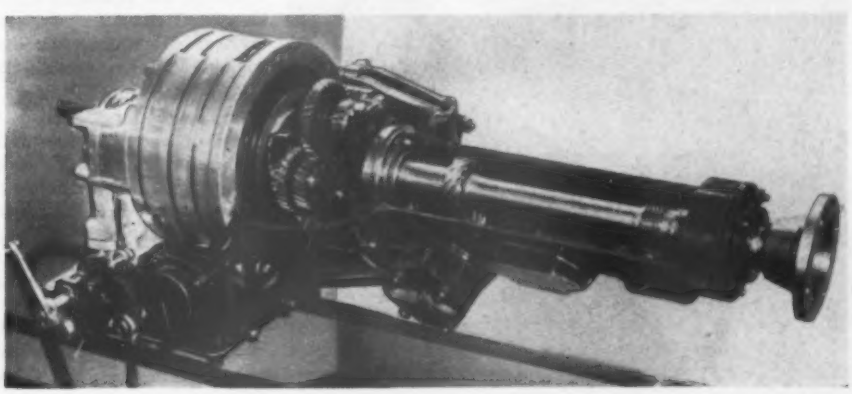
It is, perhaps, superfluous to go into great detail in respect of the Borg-Warner overdrive unit, as this has already been described on a number of occasions. Overdrive cuts in automatically above 30 m.p.h. when the throttle is released, or only slightly depressed, and it is automatically disengaged at or below 28 m.p.h. Direct gear can be re-engaged at any time by resorting to the kick-down technique, that is, by fully depressing the accelerator pedal. Under overrun conditions, it is possible to perform clutchless gear changes by virtue of the free wheel incorporated in this overdrive unit.

Hobbs Transmission Ltd., of Leamington Spa, have developed their four-speed Mecha-Matic unit to a remarkably high degree of efficiency. This transmission is suitable for any size of vehicle, and the company considers it particularly attractive for smaller cars. Its high overall efficiency is due not only to the absence of a hydrodynamic torque converter or hydraulic coupling, but also to a remarkably refined but simple epicyclic gear train. The two clutches and three similar brakes are all engaged by hydraulic pressure applied to thermally insulated diaphragms.

In general conception and detail design the Mecha-Matic transmission is undoubtedly very satisfactory from the point of view of ease of production; it is, therefore, disappointing that no car manufacturer is yet offering it at least as an optional extra. However, rumours persist that it will soon be fitted, as an optional extra, to a well known car. At present, the company is making a prototype Mecha-Matic transmission for a 2½-litre, rear-engine layout, while a similar design for a 1- to 1½-litre car has been completed some months ago.

The Mecha-Matic transmission ought to appeal to a very wide section of motorists, including those who are motor sport enthusiasts, for automaticity can always be overridden by appropriate use of the selector lever. Furthermore, the lower gear ratios are always instantly available simply by moving the gear change lever: this can be of great assistance to the driver when negotiating difficult gradients or when more effective engine braking is required.

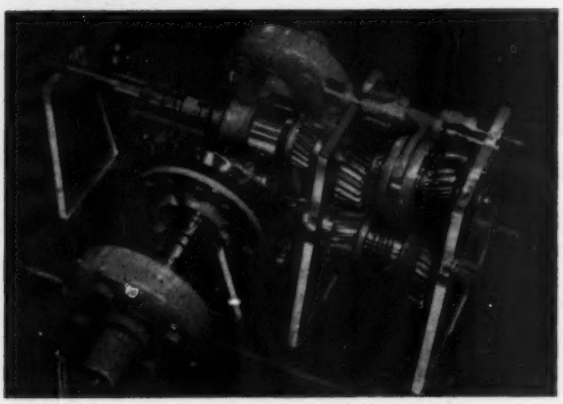
Of the Russian exhibits, the Volga is possibly a more representative product of that country than the Moskvitch, which is unmistakably of Opel origin. Although the mechanical details do not show the refinements customary on the automotive products of other nations, it would be a mistake to attribute this to lack of know-how or technical ability. Indeed, it seems to indicate an acumen for essentials.

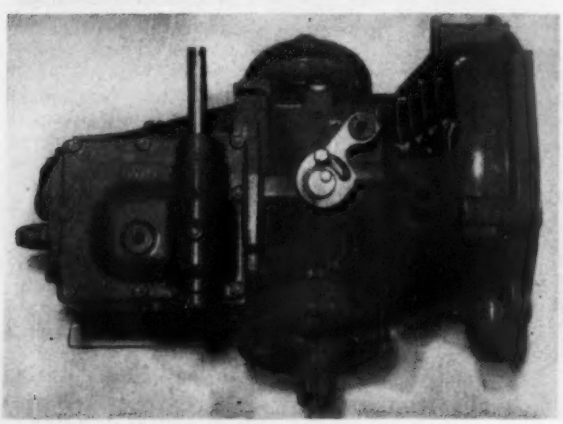


Details of the Hobbs Mecha-Matic transmission are an epicyclic gear train and a system of brakes and clutches that are actuated hydraulically. The efficiency of this transmission is very high

The manually actuated three-speed gearbox of the Volga can only be described as rugged and conventional. A one-piece layshaft, comprising four gears, constant-mesh, second, first and reverse pinion—in that order—is carried on needle roller bearings. A constant-load type synchromesh is provided for the upper two ratios only; first and reverse are ordinary crash type gears. Conventional gear tooth profiles are still used, rather than the much discussed Novikoff system, which consists of virtually semi-circular scallops in the gear, to match semi-circular teeth on the pinion—as used for dog-clutch teeth on the Thornycroft heavy trucks. Rumour has it that the Novikoff gear system will soon be applied on a vast scale, but whether the application is on cars, trucks, tractors, or general industrial gearing is not at present clear. In line with widespread American practice, an expanding shoe type transmission brake is provided for parking purposes; also, an automatic transmission, comprising a torque-converter and three epicyclic gear train, is offered as an alternative. Unfortunately, no further details could be obtained from the officials at the Show.

In the past, the Renault Dauphine three-speed gearbox has been criticized because of its gear-change control, which required an exceptionally long reach of the driver, and had an excessive free movement of the lever in every position, but this has been altered. Although a slightly higher top gear ratio—1·035 : 1 instead of 1·07 : 1—has now been provided, the steps between the gears are still necessarily large because of the requirements of starting on steep gradients and, at the other end of the scale, comfortable cruising around 60 m.p.h. On this gearbox only the upper two ratios have synchromesh, but the more positive gear-change and shorter gear lever travel are a great improvement. A four-speed, all-synchromesh gearbox is standard on all Renault-Gordini cars built in this country, as also is the improved gear shift control. In other respects, the transmission has remained unchanged.





Shown in these two illustrations is the SAAB transmission manufactured by the E.N.V. Engineering Co. Ltd. The gearbox and final drive form a single, compact unit, and a manually controlled free-wheel is incorporated

The history of NSU dates back to 1873, and after manufacturing knitting machines and rising to a dominating position in bicycle and motor-cycle manufacture, they finally began to produce motor cars. Their first tentative ventures in automobile engineering took place in 1888, and motor cycles were added to the company's products as early as 1900, but the first cars left the factory at Neckarsulm in 1906, when Einstein's sensational relativity theories astonished the world. Automobiles have been made by NSU since those early days, with only a temporary voluntary interruption dictated by the fickle economic conditions that prevailed in 1929. The illustrious Gottlieb Daimler and the late Professor Porsche found NSU to be the most suitable firm for the translation of their advanced ideas of automobile design into reality; in fact, Professor Porsche developed early Volkswagen prototypes at NSU.

It is, therefore, not surprising that a new motor car project conceived against this background has made a considerable impact. In keeping with tradition, many details of the design of the NSU Prinz, in production since 1958, are developments based upon motor-cycle experience. The air cooled, almost vertical, twin-cylinder engine forms an extremely compact unit with the four-speed constant mesh gearbox and final drive. Transmissions are available with either ordinary dog engagement or with synchromesh on all four forward gear ratios. A large, overhung, single-helical gear takes the drive directly from the pinion, whilst all the other gears, except first, have straight spur teeth. The single-helical first gear is necessary for quiet operation, since it also meshes with the fairly large final drive gear. A two-pinion differential is built into this final drive, so that the distance that separates the inboard Hookes type joints on the live half-shafts is a minimum. There is an apparent similarity between the NSU layout and the Mini-Minor and Austin Seven arrangement, even to the point of a common sump and lubrication system for the engine and the transmission. The NSU transmission assembly has the slight advantage of being far more compact—after all, it was specifically designed for this application.

Among the smaller cars, the Panhard type PL17 now has synchromesh on the upper three ratios—former models had synchromesh on only second and third gears. Similarly, the attractive D.K.W. Junior and the D.K.W. 1000S now have synchromesh on all forward gear ratios. The new Lloyd Arabella and the B.M.W. 700 show the same refinements. Although the smaller Goggomobils are still fitted with the Getrag electro-magnetic preselector gearbox, the popular T700 model is equipped with a four-speed gearbox which has the Porsche type synchromesh for all forward ratios.

An interesting display on the E.N.V. Engineering Company's stand was a complete SAAB transmission assembly, as well as its working parts, neatly assembled and supported by thick Perspex brackets. This transmission was designed and developed by SAAB engineers, but is made by E.N.V., at their Willesden factory. It is a compact assembly housed in a one-piece casting comprising bell housing, final drive casing and gearbox. As is well known, two-stroke engines do not idle readily, but this problem was overcome by fitting a roller type free-wheel to the input shaft. A sleeve on this shaft can be engaged with the dog teeth of the free wheel's outer member in the same manner as the gears in a layshaft type box are normally engaged.

In principle, the SAAB gearbox is a three-shaft design, the third shaft being integral with the spiral bevel pinion. This shaft also carries the final drive gear, immediately behind the front bearing, and the reverse gear at the back, the space between them being occupied by the speedometer drive spiral gear. Thus, it was possible to accommodate three forward and one reverse gear in a length which, in more conventional synchromesh gearboxes, will accommodate only two gears. The constant-mesh gears—input to layshaft—are immediately behind the free-wheel, in line with the spiral bevel pinion, and, therefore, are actually in the final drive casing.

First and reverse are obtained by connecting the appropriate pinion with the layshaft, but the sychromesh gear-change mechanism for second and top gear ratios is on the input shaft, above the output shaft. The forward extension of the input shaft passes very close above the bevel type differential, which is between the clutch and gearbox. Proprietary universal joints, apparently of steel-sheathed rubber, fit snugly against the final drive casing. A transverse selector shaft is located in the gearbox cover; it is moved from left to right for gear selection and rocked fore and aft for actual engagement: this arrangement, of course, is often adopted on remote control commercial vehicle gearboxes. The general impression is that this gearbox is a well engineered and neatly designed transmission made with the precision that is invariably associated with E.N.V.

A review of automobile transmissions would hardly be complete without reference to the Borg-Warner and Laycock-de Normanville overdrive. It should be clearly understood that the primary function of an overdrive is to give better fuel economy rather than higher maximum speed. Indeed, if the engine and normal transmission have been carefully matched for a given performance, the maximum speed in overdrive should be less than in normal top gear, except when gradient and wind favour the overdrive gear by reducing the power requirement for a given speed. Before the War, when the subject of overdrives was vehemently debated, it was pointed out that maximum benefits are derived by fitting an overdrive and modifying the axle ratio so that the maximum speed of the car, in overdrive, is the same as it was before the overdrive was fitted.

The Borg-Warner automatic overdrive gives an engine speed that is 30 per cent lower than in direct drive. It is fitted, in place of the gearbox extension, between the gearbox and the propeller shaft. An electrical, speed-sensitive governor switch, driven off the output shaft, makes the overdrive automatically available at any speed above 32 m.p.h. This governor controls a relay switch, which causes a solenoid to be energized to move a pawl into engagement with the sun gear of the epicyclic gear train. However, the pawl and overdrive engagement cannot take place until the accelerator pedal is momentarily released. This sequence of operation has the advantage of reducing engine speed and so ensuring shock-free engagement of the overdrive ratio.

Downward changes out of overdrive occur automatically at about 27 m.p.h., or at higher speeds by means of a kick-down change effected by a sudden and full depression of the accelerator pedal. For this operation, the ignition is momentarily interrupted, to ensure sufficient unloading of the pawl to obtain immediate disengagement. This overdrive ratio can be used in combination with any gear ratio that permits road speeds of more than 32 m.p.h.

An essential feature of the Borg-Warner overdrive is the sprag type free-wheel. Manual control is also provided, and this facilitates the locking out of the overdrive by connecting the sun gear with the planet carrier. However, this control knob must not be pulled out when the overdrive is engaged or when the car is free-wheeling. Towing or push-starting can be carried out, as recommended for the particular vehicle.

An aluminium casing is employed for the neat, four-speed gearbox of the Goggomobil T700. Porsche synchromesh is employed on all forward ratios

The Laycock-de Normanville overdrive unit, so popular on many high-quality cars, has been considerably refined in its general conception. Orginally, the unit was conceived as an underdrive, to go in front of the conventional gearbox but, when it was realized that this would necessitate considerable alteration and modification of most orthodox gearboxes to which the unit was to be fitted, it was redesigned as an overdrive.

This overdrive is a completely self-contained unit. It incorporates a plunger type pump, hydraulic accumulator, compound epicyclic gear train, roller type free-wheel, a

Unusual compactness has been achieved in the design of the NSU Prinz gearbox and final drive unit. All four forward gears have synchromesh

double-acting cone clutch, and a solenoid-operated control valve. Although this overdrive is perhaps more complicated than the Borg-Warner unit, it is certainly completely reliable, as many Jaguar, Rover, Triumph, Austin-Healey and Humber owners will readily testify.

Originally the Laycock-de Normanville overdrive was controlled by mechanical linkage connected to the gear-change mechanism. This limited its application to top gear but, with the introduction of the more satisfactory manual and solenoid control, it can be applied to any gear ratios. There are two models to choose from: they are the original A type, for cars of 2 litres and over; and the D type, for smaller cars such as Sunbeam, Hillman Minx, and the small Ford and Vauxhall models.

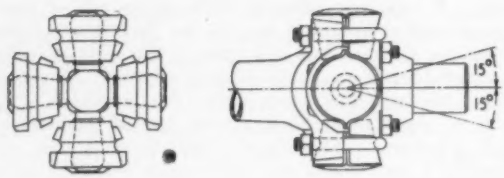
Propeller Shafts and Final Drive Units

Sealed Universal Joint and Constant-Velocity Joint in Large Quantity Production; an Ingenious Differential Layout and New Limited-Slip Differentials

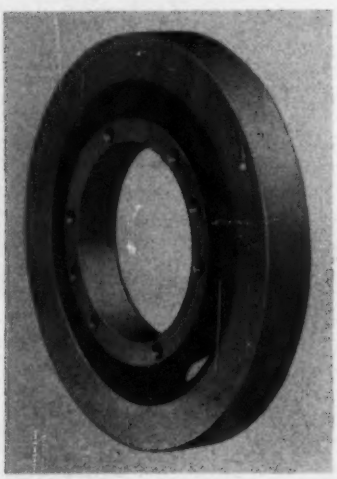
BRITISH motor car manufacturers have indeed been fortunate in that the manufacture of universal joints and propeller shafts has for many years rested overwhelmingly upon the shoulders of Hardy Spicer Ltd., who have never made the mistake of assuming that commercial success obviates the necessity for improvement and progress. Despite the limited scope for introducing spectacular innovations on simple Hookes-type joints connected by tubular shafts, progress nevertheless is apparent. For example, needle roller bearings are now used where previously plain bushes had to suffice, and the latest development, apparent on the Triumph Herald, indicates that the need for service-free propeller shafts has not been overlooked. Nor has success with this particular solution of the problem inhibited other experimental investigations.

Without the remarkable advances in production techniques the Hardy Spicer propeller shafts could hardly have been established so firmly in competitive markets, even far beyond our native shores. Recently the Birfield-Rzeppa constant-velocity joint has been added to the range in large quantity production, and it is a standard fitting on the new Morris Mini-Minor and Austin Seven front wheel drive cars.

Two other companies, the Moss Gear Co. Ltd., and one belonging to the Sankey group, are engaged in propeller shaft manufacture. The former is producing the American Mechanics type of joint primarily for agricultural and other special purpose machines, whilst the latter is making ordinary needle roller bearing Hookes-type universal joints and



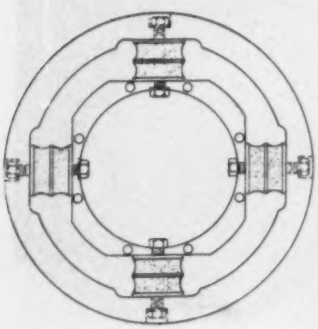
On the B.M.C. ADO 15 cars, the inboard pair of universal joints is of a new design evolved by Moulton Developments Ltd. The conical rubber bushes are bonded to the spider and are clamped to the housings

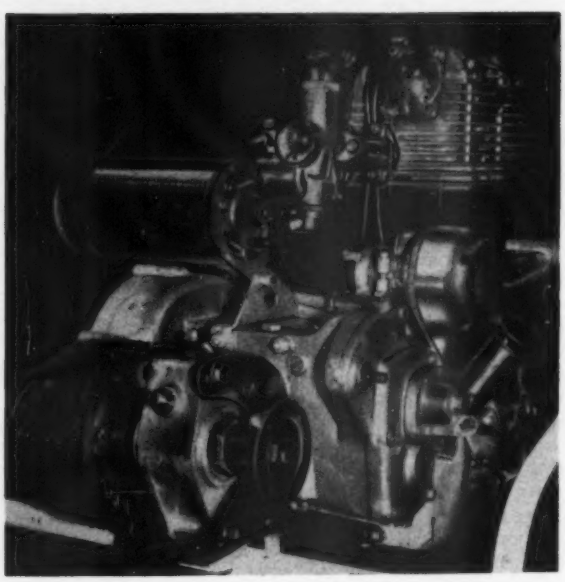


Left: A Metalastik vibration damper of the bonded rubber type available for use on the propeller shafts of private cars

Right: In the Berkeley, the differential is driven by open chain and is adjustably mounted behind the Albion gearbox unit

Below: Another type of damper, also produced by Metalastik, embodies rubber sandwich blocks





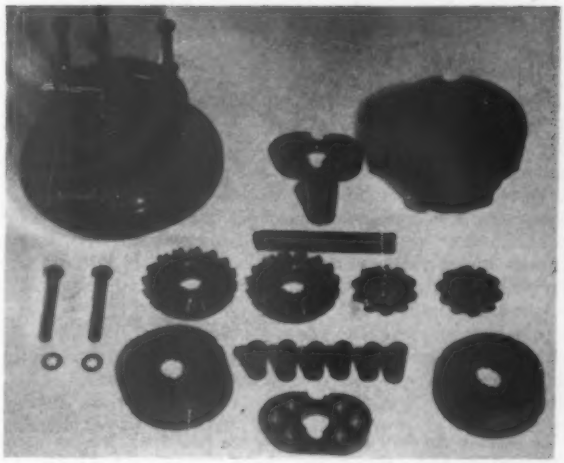
propeller shafts. In addition, they are developing a production technique for the ingenious, Chobham designed, constant-velocity joint.

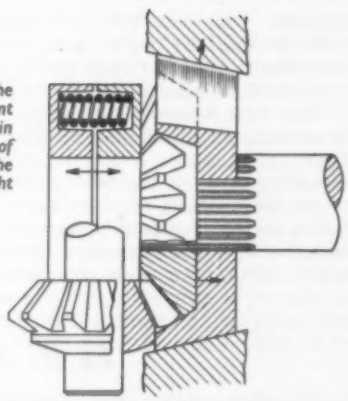
Transmission line vibration and resilience problems have been with us since inception of the automobile and they are once more under close scrutiny. One reason for this is that transmission lines tend to become shorter and another is that engine outputs and speeds are rising. Front engine front wheel drive and rear engine rear wheel drive cars seem particularly beset by lack of torsional flexibility in their transmission systems. A solution to this problem has been found by the collaboration of B.M.C. engineers and technicians with their associated company, Moulton Development Ltd., Bradford-on-Avon. The two teams have evolved a patented, rubber drive-coupling consisting of a forged steel spider, to which are bonded four conical rubber bushes. These are assembled to the forked, driving flanges by means of thin pressed steel shells and U-bolts which pre-compress the rubber. Shaft angularities up to ±15 deg can be accommodated by this kind of coupling; these deflections compare well with those acceptable for normal universal joints.

Another contribution towards smoother transmissions has been made by Metalastik Ltd. This is the provision of transmission dampers to reduce, or even eliminate, resonant torsional vibrations and hence transmission noise. One type is similar to the vibration dampers used at the front ends of crankshafts; it comprises two concentric rings bonded together by the requisite amount of a suitable quality of rubber. The inner ring is sandwiched between the companion flange of the transmission or final drive and the flange of the universal joint, so that the inertia of the outer ring damps the torsional vibrations. The second type is based upon a similar principle, but four standard, rubber sandwich blocks are interposed between the inner and outer rings. Yet a third type can accommodate considerable angular deflections whilst transmitting low torque, until rubber buffers limit the deflection as the torque rises. It is, in fact, a flexible coupling rather than an inertia type vibration damper. This coupling should be fitted, preferably, between the engine and gearbox.

On the Triumph Herald, with independent suspension on all four wheels, there of course is a fixed final-drive casing. An ordinary swing axle arrangement, with live half-shafts, has been adopted, wheel movement being controlled by the suspension system. The final drive is a straightforward spiral bevel unit with a two-pinion differential.

Once more, SAAB engineers have departed slightly from the conventional, with the design of their differential. According to E.N.V., who manufacture it, the production cost of this unit compares favourably with more orthodox designs. Differential cages generally have spherical seatings against which the bevel pinions bear. Since there are only two of these pinions in the SAAB differential, the designers have been able to arrange the spherical portion so that not only the bevel pinions but also the half-shaft gears bear in the one spherically machined portion, as shown in the accompanying illustration. Each half-shaft gear has a groove, for a snap ring, in its splined bore: this divides the bore in two, and a nut with external splines fits into the outer end while the hollow half-shaft is carried in the inner end. A long set-screw locks the shaft and nut together, to



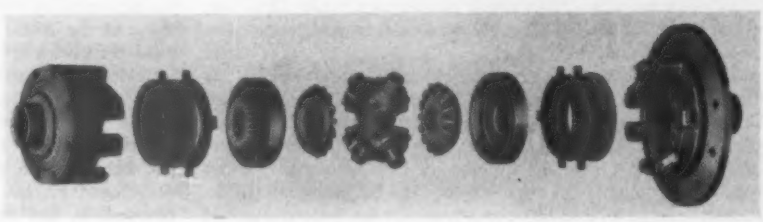


Above: The components of the Borg-Warner Spin-Resistant differential, widely used in the U.S.A. Its principle of operation is shown in the illustration on the right

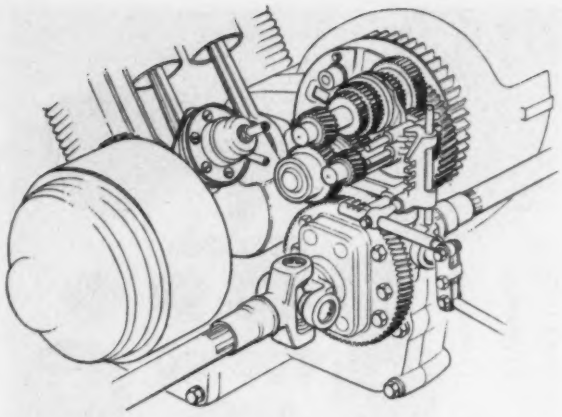
locate the half-shafts. Two of the set-screws by means of which the crown wheel is attached to the differential cage, are extended to trap the pinion shaft between them. Evidently a great deal of thought went into the detail design of this final drive and differential unit.

For a great many years, the ZF limited-slip type differential has been practically the only device available for improving the distribution of tractive effort on slippery

This cut-away housing of the SAAB differential shows the spherical form of the seating face for the pinions and gears



The Salisbury Powr-Lok limited-slip type of differential, here seen dismantled, embodies two multi-plate clutches. These are fitted between the half-shaft gears and the housing



The gearbox and final drive layout of the NSU Prinz. Helical gears transmit the drive from the gear cluster to the small differential unit

surfaces. This year, two other devices for this purpose, both of American origin, were exhibited. They are the Borg-Warner Spin-Resistant differential, and the Salisbury Powr-Lok differential.

The Spin-Resistant differential, produced by Borg-Warner Ltd., Letchworth, is already widely used in America. Except for a modest static pre-load exerted by springs, the separating force on the bevel gears within the differential is all that provides the frictional resistance to differential action, and this resistance is therefore approximately proportional to the torque transmitted. The ends of the differential gears bear in two co-axial, cone-shape cups, the minor diameters of which face outwards towards the wheels. Two thrust blocks, with six springs interposed between them, press the differential gears into the cups, and the cups against the differential housing. As the torque increases, so also does the separating force due to the reaction between pinions and gears: hence an increasing force resists differential movement and thus, by preventing wheel spin, ensures greater traction on slippery surfaces.

Salisbury Transmission Co. Ltd. is manufacturing the Powr-Lok differential, under licence from the Thornton Axle Co., U.S.A. This device has been produced for a number of years by the Dana Corporation of Toledo, who market it under the name, Spicer Thornton Powr-Lok. In principle, the Salisbury Powr-Lok is similar to the Borg-Warner device, but instead of the conical cups there is a pair of multi-plate clutches and adaptors between the half-shaft gears and their housing. The ends of the cross-pins register in V-notches in the differential cage, and when a load is applied, these pins ride up these V-notches and thus exert pressure against the multi-plate clutches to resist differential action. Under ordinary driving conditions the differential operates normally, and the locking device becomes effective in order to prevent one wheel from spinning. Neither the Salisbury Powr-Lok nor the Borg-Warner Spin-Resistant differential can be applied to an unmodified existing unit. Two-piece differential housings, appropriately machined, are necessary for both.

Vauxhall Motors Ltd., have not made any startling changes on their models, but they have long had a reputation for advanced production methods, all of which make their contribution to cheaper and better automobiles. A recent example is in respect of the splines on half shafts, which are now rolled instead of hobbed. This is more economical; and grain flow and surface finish are much better than hitherto.

REAR SUSPENSION

Live Axles Remain Preponderant; Modifications to Give Improved Riding Qualities; New British Independent Layouts

ON the majority of cars, the rear suspension system still embodies a live axle. Only one model with independent suspension for the rear driving axle has been introduced by a manufacturer who had previously used a live axle. Another company has changed its form of suspension completely, namely A.C. Cars Ltd., on the new Greyhound model. The adoption of front wheel drive for the new Austin and Morris small cars has permitted the use of simple, space-saving suspension units. These B.M.C. models were the only cars exhibited with rubber as the sole springing medium.

Modern laminated springs generally have blades of plain rectangular cross section, but it was interesting to see the return of the grooved blade on the new Plymouth Valiant. A four-blade, 2½ in wide spring is used and although, as is very desirable, the master blade is plain, the others are grooved. To obviate any tendency to squeak, blade inserts are pegged in position and the ends of the blades are tapered in thickness.

Independent rear suspension has been used by A.C. for many years, but on the Greyhound model another layout has been introduced. It consists of a single three-quarter trailing wishbone to which the wheel bearing housing is attached. The outer arm of the wishbone consists of two tubes, one above the other, spaced apart at the hub end and converging to join at the pivot bush. A reinforced, large-diameter tube forms the inner arm. To minimize tooling costs, these wishbones are designed to be interchangeable; rubber bushes are used at the pivots. An Armstrong coil spring and damper unit incorporates the bump and rebound stops, and is installed just to the rear of the hub. In the static laden condition, the wheel camber is 1 deg, negative. With a single trailing arm or wishbone type of suspension the rear of the car does not rise when the brakes are applied; in fact, if the arm is relatively short, brake reaction may cause it to be lowered.

A trailing arm independent suspension layout is employed on the new Austin Seven and Morris Mini-Minor cars. On the end of the leg of the tubular, T-shape arm is mounted a flange for the hub, and the arms carrying the widely spaced bronze bushes bear on a hardened steel pivot. A grease nipple on the end of the pivot assembly is the only point requiring periodic attention. Formed below the housing of the inner bearing is a lug, which is drilled to receive a nylon cup to house a hardened pin in the long, conical tubular push rod of the suspension spring unit. Since the front and rear weight distribution of the fully laden car is approximately equal, the rubber springs at the rear are common with those at the front; the rear springs have the same leverage ratio, 5 : 1, as is employed on the front suspension. Identical load/deflection curves are obtained for all four wheels, by using a common curved pressing for attachment to the inner spring cone. On the rear spring units, another curved pressing, housed inside the end of the outer cone, obviates the need for an additional bump rubber. The rebound movement of the road wheel is limited by a stop incorporated in the telescopic damper attached to the arm.

On the other models in the Austin range—the A40, A55 and A99—rear wheel drive of the orthodox live axle layout is employed. The movement of the semi-elliptic springs is controlled by Armstrong lever type dampers. Spring rates rise, of course, as the rear end weights increase, and on these models the rates are respectively 105, 157 and 185 lb/in. On the A55 car, a layer of rubber is fitted above and below the spring, and a packing-piece, $\frac{1}{2}$ in thick, is interposed between the spring seat and the pressing that retains the rubber. A forward extension of the spring seat provides an anchorage for the damper connecting link. Between the U-bolts is a tall bump rubber, which comes into operation when the axle is deflected upward by only $1\frac{1}{4}$ in from the normal laden position.

An anti-roll bar is fitted between the damper arms on the A99 model, and the damper link is connected at one end to the inner of a pair of angle bracket pressings, attached by the spring fixing bolts to the upper, spring retaining plate. To eliminate body boom, wide and long fabricated brackets are welded to the axle tubes, to receive two rubber bushes. The bushes, which form the connection with the angle brackets, are 6 in apart, and are equidistant from the centre of the axle.

One of the most serious problems that automobile designers have to face is that of vibrations travelling down the transmission, through the axle, along the springs and into the chassis. This phenomenon is sometimes overcome by employing large, eccentric rubber bushes in the front eyes of the springs, by repositioning the spring shackle points on the chassis. In the shackles at the rear ends of the $1\frac{3}{4}$ in wide springs of the A99 car, Harrisflex bushes are employed. Each shackle is triangular in shape, to carry a rebound rubber designed to come into contact with the underside of the frame member, at a point forward of the shackle bracket and at a predetermined distance from the centre of the spring eye.

A double wishbone type of independent suspension was fitted to the Cooper racing car exhibited. Above the top wishbone is a transverse laminated spring, which is attached to each vertical link casting by means of a short shackle. Since the makers state that the top wishbone is optional, it can be assumed that, if this is not fitted, the spring is connected directly to the vertical link. The spring is not bolted to the chassis members: although it is restrained laterally, its whole length, except for a very small section in the middle, is free to deflect. A clamp plate is linked to the chassis to locate the spring laterally, and fore-and-aft movement is restricted by side plates, which are bolted to the two tubes supporting the rear end of the body. The spring eye centres are 38 in apart, and these tubes are normally $17\frac{1}{2}$ in apart, but alternative holes are provided in order that the distance between these supports can be varied from 15 to 19 in. Attachment of the spring in this manner allows the centre portion, between the supports, to deflect with the road wheels; under cornering conditions however, the effective length of spring, controlling the rate of each wheel, is reduced. Not only can the static deflection at the rear be varied by altering the positioning of the support tubes, but also the roll stiffness is reduced or increased, according to whether the spacing of the tubes is reduced or increased.

The wishbones are of tubular construction, and the upper and lower ones are of unequal length; detachable inboard pivots screw into threaded bosses welded to the arms of the upper wishbones. This arrangement provides a means of adjusting the camber of the rear wheels. Armstrong telescopic dampers are fitted and each incorporates an adjuster for varying the valve settings. All the suspension pivots have metal bushes, lubricated through grease nipples. The use of a laminated spring can only be justified on a car of this type, where reduction of weight is so vital, on the grounds of the two functions it fulfils, and also possibly of the simple manner in which the ride can be varied.

A conventional Hotchkiss drive is employed on the Daimler SP250 sports car. The axle is solidly clamped to the springs, forward of their centres. To obtain constant frictional characteristics of the springs, buttons are provided on the second, third and fourth blades. Because the frame side members pass beneath the axle tube, road wheel movement is restricted to 3 in between the rubber bump and rebound stops. While this movement appears small, it is only under extreme cornering conditions that it might be found to be restrictive; in such cases, the inner wheel would tend to lift or spin if a high torque were being applied. Relatively stiff springs are used, having a rate of 150 lb/in, and control is provided by Armstrong DAS 10, lever type dampers, each of which is attached to a double ribbed bracket on the chassis frame; a short, rubber bushed shackle connects the damper arm to the plate on the road spring. The roll-centre height is 10·9 in, and the roll stiffness is stated to be 160 lb-ft/deg.

A live axle is employed on the new Ford Anglia model, and the only unusual feature of the layout is the adoption of what used to be termed a rebound leaf. This leaf is positioned above the master blade and, in this instance, it has been found beneficial in reducing the tendency of the road wheels to hop during cornering when the vehicle is lightly loaded. Relatively soft suspensions have been a feature of the post-war Ford cars, and on this particular model the roll stiffness is only 100 lb-ft/deg.

Although the swing axle design of the latest Mercedes-Benz 220S saloon is basically similar to its predecessors, it employs certain new features. The measures taken to insulate the transmission from the body, so as to give freedom from boom, have resulted in a very interesting layout. Both the divided axle and the coil spring anchorages are connected to substantial cross members, and rubber packings are fitted above the coil springs. Lateral location of the

On the Cooper racing car, a double wishbone arrangement is employed for the rear suspension, in conjunction with a transverse leaf spring. Holes in the spring brackets permit adjustment of wheel rate and roll stiffness

axle is effected by a link with a rubber-lined connection to a bracket suspended from the cross member. The differential housing is supported on a pendant shackle attached to the housing but insulated therefrom by rubber. At its upper end, the link is carried by a resilient mounting, formed by inner and outer cone-shape steel pressings bonded to a rubber buffer. Only limited vertical movement is permitted by the mounting, and large flanges are formed on the shackle above and below the rubber to form progressive stops. As with other Mercedes models, the differential housing is situated off centre, and the axle tubes are pivoted as low as possible on the longitudinal axis of the car. A compensating spring has now been introduced, and is fitted between arms attached one above and to the rear of the housing and the other to the right-hand axle tube.

Telescopic hydraulic dampers, having an inward inclination, are attached to the axle tubes as close as possible to the wheels. The upper anchorage for each damper comprises a tower-shape pressing welded to the rear of the cross member. Longitudinal location of the axle is effected by trailing arms, attached to pivots below the axle tubes, and the coil springs are mounted on these arms, just forward of the axle. The leading ends of the arms are attached by rubber mountings to brackets on the main body cross member. These mountings are similar in shape to those used for the shackle that carries the differential housing, and the inner cone is secured to the cross member. Each suspension arm is pierced and flanged for attachment to the outer cone pressing.

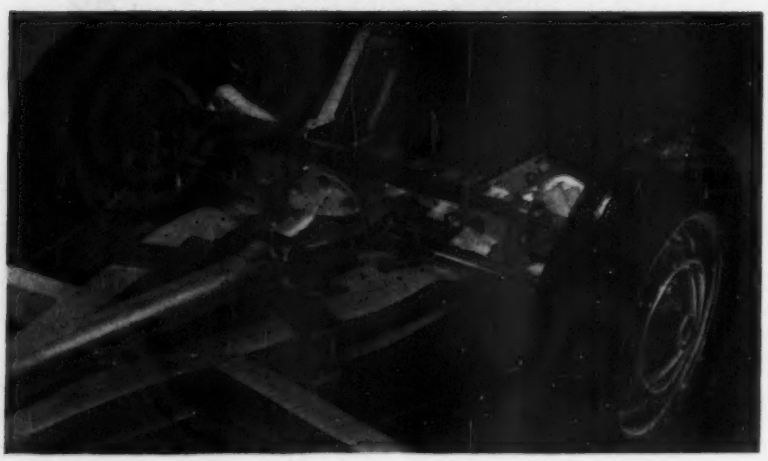
With the introduction of the Porsche Super 90, with a swing axle, greater stability has been found necessary. Accordingly, an additional fitment is connected to the differential housing: it consists of a single leaf spring, the ends of which are attached by link rods to the axle tubes, at points adjacent to the hubs. A rubber pad is interposed between the spring blade and its central attachment bracket. From this pad the spring tapers in thickness to its ends. Upward movements of either or both wheels cause the spring to bend about its attachment bracket; there is no increase in roll stiffness, since the spring is not rigidly held.

On each of the Renault models exhibited, a new device, known as the Aerostable, has been incorporated as an additional springing medium. Welded on the half axle tube, just inboard of each coil spring, is a saddle pressing to form an anvil for the air spring. This spring consists of a rubber diaphragm secured peripherally in a pressing attached to the body member. Air is contained between the diaphragm and the pressing and is at atmospheric pressure when the unit is not in operation. At larger axle deflections, the anvil pressing on the axle tube comes into contact with the diaphragm, and compresses the air.

The coil springs now have a lower rate, which permits a softer ride in the lightly laden condition. To accomplish this improved ride without a helper spring would have necessitated the rear of the car being raised, and the stability of the car under cornering would have been adversely affected. The shape of the diaphragm and the anvil have given an effective rising rate characteristic to the suspension, with no loss of bump clearance when the car is laden. In fact, with such a high final rate, an even smaller clearance could be given.

On the Russian Volga models, the axle is mounted on semi-elliptic laminated springs, which are controlled by lever arm dampers attached to the body and connected to the lower spring plates by rubber bushed links. These dampers are of the opposed piston type, which appear to be identical with those of Girling design. The springs are greased on assembly and are gaitered to obviate the need for further attention. The axle of the Moskvitch models is also mounted on semi-elliptic springs, the action of which is controlled by telescopic dampers having an inward inclination.

Modifications have been carried out to the orthodox rear suspension layout of the new Simca Aronde 60. The live axle is rigidly attached to semi-elliptic springs of unusual design, and coil type assister springs are interposed between the axle and the body frame members. The lower pans for



Above: The rear wheels of the Austin Seven and the Morris Mini-Minor are independently mounted on trailing arms carried on the rear sub-frame. Rubber suspension units are employed, and have a leverage ratio of 5 : 1

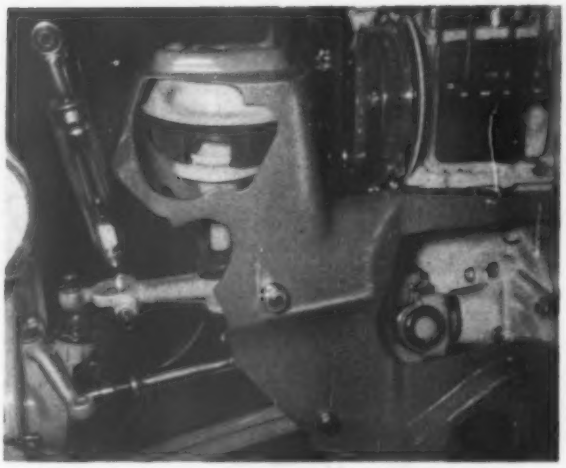
Left: A swing axle type rear suspension is a feature of the Triumph Herald. The leaf spring is shackled to the wheel hubs, and trailing arms provide longitudinal location; the dampers are attached to the shackles

these coil springs are situated immediately above the inner U-bolts of the laminated springs.

Although the axle is fixed to the middle of the semi-elliptic springs, the flexibility of one end of these is vastly different from that of the other. At the forward end of the spring, the blades are extended almost to the eye, so the amount of wind-up due to torque reaction is reduced considerably; additionally, the axle nose piece remains lower than with the previous design, and advantage has been taken of this to reduce the height of the propeller shaft tunnel in the floor. One blade is positioned above the master blade, and depends upon its two clips for its contribution to normal springing and forward driving torque reaction. Because of this arrangement, the rear half of the spring has to be very flexible to give the desired axle deflection under load. This flexibility is obtained by having the two lowest blades very short, and another of three-quarter length. The spring movement is controlled by telescopic dampers, attached to the lower spring plate and inclined forwards and inwards: the forward inclination helps to some extent to damp the torsional deflections of the axle. Bump and rebound stops are both embodied in the dampers.

A conventional rear suspension is employed on the Sunbeam Alpine sports car, and relatively soft springs are used, having a rate of only 110 lb/in. With adequate damper control this low rate is advantageous, especially since the frame passes over the axle and rebound movement is less limited than on certain other models, for which spring rates have had to be carefully chosen to suit the very limited space available. There is 2¾ in of bump travel before the axle contacts the rubber stops. The Armstrong lever type dampers are bolted to the floor structure behind the axle.

An independent suspension layout of swing axle design is employed on the Triumph Herald. The differential housing is flexibly mounted on the chassis frame, and a transverse, laminated spring is clamped to the top face of the housing. Long shackles of pressed steel construction connect the ends of the spring to the hubs; a downward extension of the shackle provides an anchorage for the telescopic dampers,



Rubber spring units are employed also for the front wheels of the B.M.C. small cars. They are mounted above the forged upper transverse arms. The I-section, lower arms are braced by obliquely mounted drag links

which are inclined inward. Fore-and-aft location of the wheels is provided by trailing links having rubber bushed pivot eyes. The forward end of each link is attached to brackets bolted to a frame cross member, and adjustment to wheel alignment is effected by shims at this point.

The spring gives a wheel rate of 75 lb/in, and a total wheel movement of 6½ in is allowed. Both the bump and the rebound stops are provided by the dampers. A very high roll-centre is obtained by the wide spacing of the universal joints of the axle shafts; with two people in the car, the centre is 15¾ in above the ground, in the case of the saloon, and in the fully laden condition this figure is reduced to 14¾ in. The roll stiffness of the complete suspension is 126 lb-ft/deg for the saloon and 109 lb-ft/deg for the coupé.

Front Suspension

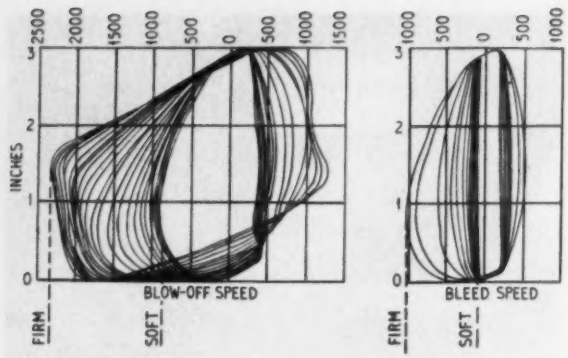
Rubber Components Being Applied Increasingly; Adjustable Hydraulic Dampers Now in Production; Greater Attention to Reduction of Routine Maintenance

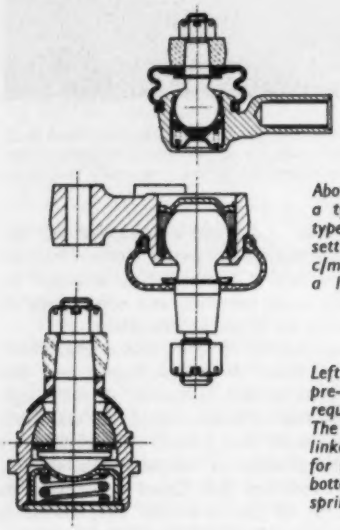
PRIOR to 1939 there were few cars produced in this country with independent front suspension and, invariably, laminated springs of high rate and friction characteristics were used in conjunction with the beam axle. Consequently, little additional damping was necessary and, as a result, dampers fitted to the majority of quantity-produced cars were in what proved to be very early stages of development.

With the independent suspension systems came the greater use of coil springs or straight torsion bars which, of course, have little inherent friction. At the same time, static deflection of the wheels had risen to three or four times those permissible with beam axles. This advance in respect of ride comfort and technique, combined with the fact that cars were being exported in increasing numbers to countries where roads were very bad, placed a considerable burden squarely on the shoulders of the designers of dampers. Progress has been slow and it has taken, in some cases, ten years for telescopic dampers to meet economically the demands of modern motoring, that is, in respect of reliability, minimum maintenance and freedom from fade.

Dampers capable of being adjusted from the driving seat have been a feature on a number of high-quality cars in the relatively expensive range for a number of years, but there have been few, if any, mass produced hydraulic dampers that can be adjusted *in situ*. The news that Armstrong Patents Co. Ltd. has now marketed a new unit with an external control will certainly be welcomed by car manufacturers. It may now be possible to have dampers set to suit the requirements of this country and, by turning the control, produce settings acceptable in certain overseas countries, where much harder damper settings are necessary. Sports car manufacturers will also be interested in these new units, one version of which is fitted to the Cooper-Climax racing car.

Two types of dampers are at present being manufactured by Armstrong Patents, the DAS10 lever-arm type and a telescopic unit, type AT9. Adjustment to settings can be easily made either directly on the dampers or, from the driver's seat, by a simple mechanical control. The average owner is not so critical a judge of suspension damping as are the car manufacturers, but there are some who wish to have higher or lower damping settings than those chosen





Above: Work diagrams given by a typical Armstrong adjustable type damper. The blow-off settings are obtained at 104 c/min and the bleed settings at a lower speed, only 9 c/min

Left: Three types of Thompson pre-lubricated ball joints, which require no periodic maintenance. The upper joint is for steering linkages, and the other two are for suspension applications, the bottom one being used where the spring loading is transmitted

for them. When the damping is inadequate, complaints are relatively numerous, but, surprisingly, very few drivers ever query a harsh ride.

At present, the bump and rebound, blow-off and bleed settings are all raised or lowered by turning the control one way or the other, and the twenty variations can be seen in the accompanying illustration of a typical test card. Whether such fine adjustment is necessary, only experience will tell. With normal dampers in everyday use, the acceptable production tolerances would cover several of these twenty settings and, in any case, it may be eventually found better to have fewer notches on the control, with a wider gap between each setting as the soft range is approached.

A relative newcomer in the telescopic damper field is the Telaflo unit, marketed and manufactured by Universal Dampers Ltd. They have concentrated on a 1½ in bore damper, which is larger and slightly more expensive than the other car dampers commonly used in this country. However, a number of companies is offering this unit as optional equipment. To prevent aeration, a rubber sac, at the bottom of the main body, forms an elastic reservoir for air for recuperation; thus, the air is prevented from mixing with the fluid.

Girling Ltd. has developed a new damper for passenger car use. In it, the piston and base valves now have coil springs, in place of the Belleville washers used to control the settings in the previous designs. These springs, having a considerably lower rate, obviously ensure a more consistent setting and, in addition, production assembly problems are appreciably eased. The valve layout also has been redesigned to increase the size of the operating passages for the fluid. To prevent fluid, which has passed the piston inner seal, from flowing directly into the reservoir and mixing with air-free fluid, baffles are attached to the outside of the operating cylinder and an additional tube has been incorporated. The gap between this extra tube and the outer wall of the reservoir is very small, to ensure that the returning fluid flows at a slow rate and thus to increase the time before it is again available for use in the reservoir.

Following on from the progress evident at last year's Show, in regard to the elimination of greasing points, the Automotive Products Co. Ltd. has now produced a range of Thompson universal joints, all of which are pre-packed and require no maintenance during service. There is no doubt that the life of all universal joints, whether used on the steering or front suspension units, depends to a very great extent upon the exclusion of water and foreign matter, and for this reason the lengthy development programme that has been undertaken has been well worth while. Undoubtedly, by next year's Show, far more motor cars will be equipped with them.

There are three main types exhibited: they cover applications including steering tie rods, suspension joints that carry very little load, and the more robust type for vehicles with a lot of weight on the front end. The joint developed for the tie rods has a nylon seating for the hardened steel ball-pin, and a spring-loaded cup which adjusts itself automatically during the bedding-in process. To prevent excessive vertical movement of the ball, the spring-loaded half-bearing has only a small clearance between it and a cylindrical, dished pressing in the housing; when the edge of the housing is spun over to secure the assembly, the pressing bears against the fixed nylon cup. During assembly, a molybdenum disulphide compound is introduced to lubricate the unit. The concertina type, rubber gaiter is secured by a circlip in a machined groove in the ball-housing, and a pressed washer, fitting against the shouldered neck of the ball, traps the gaiter against the steering lever boss.

The universal joint for suspension linkages is designed primarily as a road wheel swivel, and is normally attached between the vertical link of the suspension and the upper wishbone. In this design of joint, a hardened steel pin is carried in the split seating, one half of which is made from nylon and the other from impregnated cotton wick. An end-cap, secured by spinning over a small lip on the housings, compresses the two seatings against the pin. The sealing of this joint is exactly the same as for the tie rod balls.

The universal joint developed for load carrying does not have nylon ball-seatings, and a composite ball-pin is used. A mushroom shape pin is employed and a nylon thrust-washer is interposed between it and the closing plate. Axial movement of the pin is restricted by this pressing, since there is only a limited clearance between it and the closing plate. The nylon thrust-washer permits rotational movement of the pin, while angular movements are catered for by the metal bearing. Employment of nylon as a thrust-washer reduces considerably the torque required to rotate the pin and, since this application is designed as part of the road-wheel swivel mechanism, this is a noteworthy feature.

While there was undoubtedly a considerable number of new models exhibited at this Show for the first time, few companies have departed from proven designs but, owing to changes in assembly procedure or because of a need for better insulation, minor deviations have had to be made. Air suspension came in with a flourish last year, but even on the American models exhibited, only those that have been in production for more than a year have retained this springing. Variable-rate suspension systems are certainly

increasing in quantity, and ingenious devices are used to achieve the desired characteristics. Air and rubber appear to be the most popular helper springs. Only two models employ rubber as the main road-spring. The properties of this medium have been well known to the automobile engineer for a long time: variations in consistency of rubber mix, as well as climatic conditions, can affect its characteristics, and it will be interesting to see if its popularity will grow. Very few alterations are made to existing suspensions, but in some instances, where the vehicle speed has been increased, a firmer ride is provided to improve stability in the higher speed ranges.

A.C. Cars Ltd. have now included a new car in their range, and a departure has been made from the wishbone and transverse laminated spring layout that has been a feature of the products of this manufacturer for a number of years. This new car, the Greyhound, has wishbone and coil spring front suspension. The wishbones have rubber pivots at their inner ends, while at their outer ends they are attached, to the vertical link, by a ball joint at the top and screwed trunnion at the bottom. These joints also serve as the road-wheel swivels. The lower end of a combined spring and Armstrong damper assembly is carried by a rubber bush between the wishbone arms, adjacent to the trunnion. At its top end, the damper is attached with washer type rubber bushes to a 3½ in diameter tubular tower. Greasers are provided for the ball joint and the screwed lower end of the vertical link. Also, the nylon bushes in the trunnion are served by a grease nipple.

The tower to which the upper wishbone fulcrums are attached is inclined rearwards at an angle of 3 deg, to provide the castor angle. A tubular stay from the chassis is attached to each of the two towers, both of which are connected by a curved tube in front of the engine. No adjustment is provided for castor or camber, the latter angle being 2 deg. Both bump and rebound stops are incorporated in the dampers. Improved stability has been obtained on this model, by increasing the wheel track from 4 ft 2 in to 4 ft 6 in.

Without doubt, the most interesting suspension is that on the new Austin Seven and the Mini-Minor, where rubber is employed as the springing medium. The front suspension comprises unequal length arms, formed from stampings. The lower arm pivots on Harrisflex bushes and its outer end is connected by a ball joint to the vertical link. Drag loads are taken by a tie rod, also rubber mounted. Another ball joint forms the connection between the upper arm and the vertical link, but needle roller bearings are employed for the pivot at the inner end of the arm. The disposition of the arms is such that the roll-centre is 2½ in above the ground.

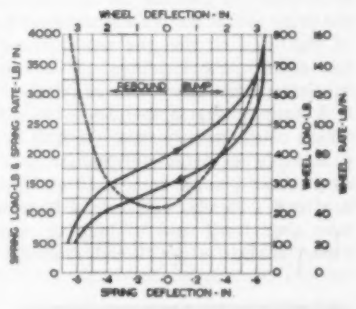
Since the front axles also transmit the drive, the spring has been accommodated above the upper arm, inside a very robust pressed member. The rubber spring comprises an inner and outer metal cone with a high-resilience natural-rubber compound bonded between them; the outer pressing is attached to the frame and the inner cone is connected, through the medium of a conical tube, to the suspension arm, which is drilled to receive a nylon cup. Movement of the spring is relatively small, since a 5:1 ratio is applied by virtue of the geometry of the system. A hardened steel ball seats in the nylon cup, and the ball stem is pressed into the small end of the conical connecting tube. On assembly, the ball is lubricated, and no further attention is required during service. A rubber gaiter prevents entry of water and other foreign matter.

A rubber bump stop is mounted under the housing for the spring and it operates against the top suspension arm. Rebound control is provided by the telescopic hydraulic damper, and this is also rubber mounted on the arm. From the normal laden condition, bump and rebound movements respectively of 3⅛ in and 2½ in are allowed. When the unit is deflected, the rubber is subjected to both compression and shear stresses, and its precisely specified shape ensures good performance from this compact and economical unit. By the employment of a pressing of special form below the inner cone, the desired variable rate characteristics are obtained. Rubber has an inherent damping quality which permits lighter damper settings to be used.

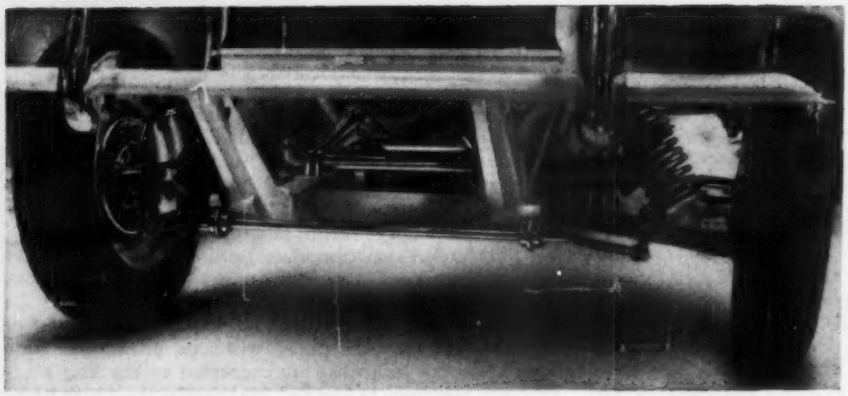
On the three larger Austin models, the A40, A55 and A99, the front suspension comprises unequal length wishbones and coil springs, the axes of the pivots being parallel to the car centre-line. The lower wishbone pivots are on shouldered cone, rubber bushes, while Armstrong lever type dampers form the upper wishbone pivots. At their outer ends, the wishbones are connected by the long king-pin, which swivels in screwed bushes. In the lower wishbone eyes these bushes are secured by cotter pins. A cotter pin also locks the king-pin in its boss. At the top, the king-pin is secured to a trunnion, which houses shouldered cone, rubber bushes for the connection to the top wishbone shackle. Three grease nipples are provided on each side of the suspension, one for the screwed trunnion and one each for the king-pin plain bushes. Thrust from the stub axle is taken on washers between the top of the king-pin boss and the trunnion. This trunnion is counterbored to provide a seal. Spring-loaded, telescopic tubes seal the inner ends of the king-pin bushes, to prevent water and other foreign matter from entering. On each of these models, the suspension system is assembled on a detachable cross member, which is rubber-mounted under the longitudinal members of the under-body structure.

Roll-centre heights of 5⅝ in, 4 in and 4 in respectively, and wheel rates of 81, 93 and 100 lb/in have been chosen. These rates are applicable over only a small range of the upward movement of the road-wheel, before the long,

Right: Graph of spring deflection against load and rate for the B.M.C. ADO 15 suspension. Note the rapid rise in rate with small departures from static conditions



Below: Double wishbones are used on the Cooper front suspension. The setting of the Armstrong dampers is adjustable



The double wishbone layout of the Triumph Herald front suspension. Inclined, telescopic dampers are employed; they are embraced by the coil springs. The suspension joints need no routine greasing

progressive bump rubbers become operative. The A40 and A55 models have a bump movement of 3 in and on the A99 it is 4 in from the normal laden position. Rebound is controlled at the upper wishbone, and the movements are 1¾ in, 3 in and 2¾ in respectively.

A double wishbone type suspension is employed on the Cooper racing car. This is a special exhibit, shown no doubt on account of its outstanding success in the 1959 World Championship Grand Prix events. The wishbone arms are straight tubes, welded at each end to bearing housings. There is also an Alford and Alder vertical link, with a screwed trunnion and a ball joint connection, respectively, to the lower and upper wishbones. The stem of the ball joint housing is screwed and locked in the top wishbone, so that it can be adjusted to set the road-wheel camber. An Armstrong combined spring and adjustable damper unit is attached to the lower wishbone, adjacent to the trunnion, and the securing bolts extend forward to provide an anchorage for the link to the anti-roll bar. The arms on the ends of this bar have alternative holes for the attachment of the links, so that the roll stiffness can be varied to suit the driver. All bearings are of the plain type and are lubricated through grease nipples.

A late arrival at the Show was the Plymouth Valiant, which came directly from the U.S.A. and concerning which practically no detail information was available. The front suspension system comprises an upper wishbone, a lateral arm and a torsion bar, with a forward extending tie rod to take drag loads and to help to react brake torque. The bump rubber is positioned relatively close to the pivot of the arm, so that a desirable rising-rate springing can be obtained from the point of initial contact of the rubber with the under-surface of the chassis side member. A rebound rubber operates against the upper wishbone on each side. Ball joints form the connection between the vertical link and the wishbone and the lateral arm. Screwed bushes in the wishbone pivots require periodic lubrication.

As on other Ford models, the new Anglia has front suspension of MacPherson type. The dampers are contained in the lower portions of the struts

It is interesting to observe how, having entered the sports car field for the first time, the Daimler Co. Ltd. has approached the problem of design to limit expenditure on tooling while, at the same time, producing a model competitive in price and with excellent performance. Most companies engaged in relatively small quantity-production are faced with the problem of minimizing costs by using many proprietary components. A close inspection of the front suspension of the SP250 sports car shows that this principle has been applied in respect of the majority of the mechanical parts.

In view of the high top speed of this car, stability is important. This has been achieved by adopting a wide track. The independent suspension comprises unequal length wishbones, and coil springs controlled by Armstrong A/T7 telescopic hydraulic dampers mounted coaxially with the springs. A ball joint connects the vertical link to the top wishbone while, at its lower end, this link is screwed into a bronze trunnion which houses Clevite bushes for the connection to the lower wishbone. Both wishbones pivot on rubber bushes, the lower one on a short bracket welded to the frame side member and the top one on a stamping bolted to the top of a pressed steel tower, which forms the seat for the coil spring. These towers are braced to the chassis members and are joined together by a curved member, which passes between the engine crankshaft pulley and the fan.

Both the bump and the rebound rubbers operate against the lower wishbone arms, which are stampings. A 5¼ in wheel travel is provided and the rubber stops, being short, do not affect the road-wheel deflection curve which, for normal wheel movement, shows a constant rate of 166 lb/in. The inner wishbone pivots are parallel to the centre-line of the car and the disposition of the wishbones gives a roll-centre height of 3$\frac{1}{16}$ in above the ground when the car carries two persons. The roll stiffness of the front suspension is 211 lb-ft/deg, so there is no need for an anti-roll bar. Adjustment to camber and castor angles is made by varying the number of packings between the lower wishbone pivot brackets and the frame member.

Undoubtedly one of the most effective and simple front suspension systems is that on the new Ford Anglia. It is known as the MacPherson type, and is now used on all the Ford range of passenger cars. This system comprises a lateral arm, a telescopic strut, and an anti-roll bar, the ends

of which take the drag loads. The anti-roll bar is clamped in pivots on the body side members and each end is attached to the arm by conical, rubber bushes. A simple top-hat shape cross member carries the conical, rubber bushed, inner pivot of the arm, the outer end of which is secured by a ball joint to the stub shaft and telescopic strut. The strut consists of a hydraulic damper unit; the tubes of this damper are secured to the stub axle and the operating rod is locked in a double ball-thrust bearing, the outer race of which is bonded to a conical rubber housing in the top of the wheel arch. Near the upper end, the coil spring seat-pan is positioned just below the thrust bearing on the operating rod, and the lower spring seat-pan is welded to the outer tube of the strut.

Rebound movement is restricted by the damper, and the top rubber mounting acts as the bump stop when the coil spring is compressed solid. Adequate wheel movements of $3\frac{3}{8}$ in bump and 4 in rebound ensure that, under normal conditions, neither stop is reached. Provision is made for a bump rubber to be fitted, should this prove necessary in certain overseas countries. The disposition of the suspension, in the normal laden condition, gives a roll centre $3\frac{5}{16}$ in above the ground.

Owing to the wide spacing of the mounting points, no adjustment is needed for wheel camber; castor can, however, be regulated by the position of the clamp on the anti-roll bar. In combination, this bar and the road spring give a roll stiffness of approximately 180 lb-ft/deg. The only point requiring lubrication is the universal joint.

Another newcomer to the Show is the American Ford Falcon, one of the new range of compact cars. The front suspension comprises an upper wishbone and a lower arm and tie rod on each side. All these links pivot on rubber bushes. Ball joints connect them to the vertical link, and these require periodic attention with a grease gun. The spring is coaxial with the damper, and both components are above the upper wishbone, to which they are attached by means of a screwed trunnion. Provision for adjustment of wheel camber and castor is made at the wishbone pivots, which are parallel to the car centre-line. The rebound stop is incorporated in the damper, while the bump stop operates against the top wishbone, at a point close to the universal joint. An anti-roll bar is linked to the lower suspension arms.

Mercedes are never afraid to depart from traditional construction methods, and their new model 220S is no exception. The front suspension is attached to a cross member which also supports most of the engine weight. Unitary construction has been employed on Mercedes cars for some time, and the attachment of this front cross member clearly indicates problems which have beset their engineers in regard to insulating the body from engine and road-excited vibrations. The suspension comprises a system of unequal length wishbones and coil springs, with the bump rubber on the bottom wishbone, inboard of the road spring. The rubber is of a long, conical shape, and it contacts the under-face of the cross member, to provide the rising rate characteristic. An anti-roll bar is also attached to the bottom wishbones by means of a rubber-mounted link. An exceptionally long telescopic damper is employed: this is attached to the lower wishbone at a point outboard of the coil spring and, passing between the arms of the top wishbone, its upper end is secured to a pressing on the wing valance.

From each side of the front cross member of the body, a shackle strip is connected by rubber bushed bolts to the front edge of the suspension cross member. Above the pressing that houses the coil spring is an attachment to the wing valance—this valance forms part of a sub-frame. Each attachment consists of two conical pressings, with rubber bonded between them, and it is obviously designed in such a manner that the flexibility is enough to damp down vibrations, while at the same time retaining the necessary rigidity for the adequate support of the suspension assembly.

To provide a variable-rate suspension on the Renault models, a special rubber spring has been incorporated. The dampers are of the telescopic type, but are mounted upside down relative to British normal practice, the operating rod being connected to the lower wishbone. Fitted between the end of the rod and the damper body is a rubber spring, which becomes operative only at approximately the laden condition. This type of rubber spring is marketed in this country by Aeon Products Ltd. and has the shape of a hollow barrel with a V-section, central groove round its bore. In general, the outside profile follows the shape of the bore, and the unit is designed in a manner such as to give a low initial rate, building up with deflection. With this spring, it is unnecessary to employ an additional bump rubber.

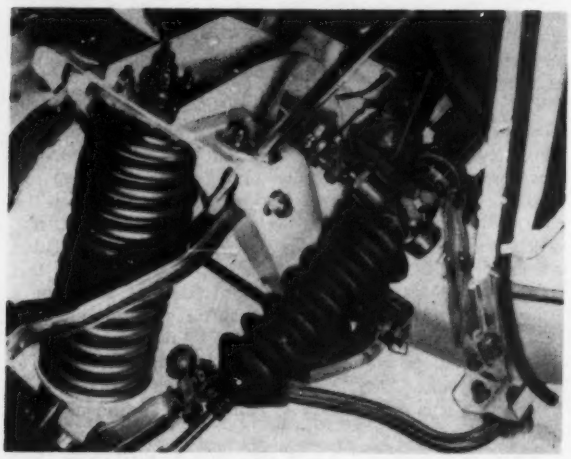
Those who expected a new approach to suspension from the U.S.S.R. were rather disillusioned when the two models exhibited were examined. It is evident that the makers have made a careful study of British designs, especially in regard to their Volga models. The independent suspension is by unequal length wishbones and coil springs, while a lever arm type hydraulic damper unit acts as the top wishbone pivot.

The arms of the lower wishbone are machined from I-section stampings and are connected together by the coil

A feature of the Simca Montlhéry front suspension is the use of ball joints to attach the outer ends of both the wishbones to the steering swivel members. These joints require regular attention with a grease gun

spring seat-pan, which is bolted to their lower faces. These wishbone arms pivot on screwed bushes, which are secured to their bosses by locknuts. A tapered vertical link connects the top and bottom wishbones and houses the king-pin, which is locked in position by a tapered cotter pin. The bosses at each end of this link are split, and the screwed bushes are locked in position by set-screws. Since the lower bush has an eccentric bore, adjustment can be made to wheel camber. Castor adjustment is provided at the top bush, which has sufficient clearance between its ends and the wishbone arms to allow for correction in respect of manufacturing tolerances. Each of the two bushes for the vertical link is on a long set-screw, which is assembled tightly into the rear arm and secured by locknut to the forward arm. During assembly, sealing washers are interposed between the wishbone arms and the screwed bushes, and compressed slightly to ensure that they are watertight.

Plain bearings, pressed into the stub axles, carry the swivel pin; vertical loading is taken on a ball thrust-bearing on each side of the vehicle. Ball bearings are also used in the hubs, the inner race of the outer bearing being retained by a castellated nut, in such a manner as to give the desired end float.



A typical rack-and-pinion steering layout is that of the Triumph Herald. The unit is held by U-bolts to attachment blocks fitted on the chassis

Both the wishbone pivot stampings and the dampers are bolted to a pressed steel cross member, which is secured by long bolts to longitudinal frame members. The pivot axes are parallel to the centre-line of the car. When the cross member is fitted, rubber insulating washers are interposed between the members and also between the bolt heads and cross member. A distance tube is fitted over each bolt, to control the preload on the rubber mountings. Each outer end of the cross member is swept downwards to carry the rebound rubbers, which operate against the top wishbones. The bump rubber is secured to a lug on the vertical link and contacts a plate mounted below the rebound rubbers.

Settings for the suspension are: camber, zero ±30 min; and castor, zero ±1 deg. An anti-roll bar is secured to the longitudinal frame members by two rubber bushes. This bar is flattened at its ends to receive vertical rods, by means of which it is connected in the conventional manner to the wishbone lower arms.

An unusual feature is a lubrication system operated by the driver. A plunger pump is attached to the dash and delivers oil to two metering valve units, one for each of the suspension assemblies. These units each have four metering valves and are adjusted to deliver oil under pressure to suit the needs of the working parts they feed. One pipe supplies the top wishbone outer bush and also the king-pin; another feeds down to the bottom wishbone pivots; and, from the rear bush, a pipe carries oil to the outer bush; other pipes lead to the steering linkage. It is surprising that the Russians should adopt a system of this nature: in Great Britain it is generally considered that the only satisfactory way to obtain positive lubrication at all points is to provide a separate pump for each: with a coupled system, the oil invariably flows out through the greatest clearance and, as a result, the other bushes are starved.

The second Russian model at the exhibition, namely the Moskvitch 402, is completely different from the Volga. In fact, a study of its design suggests that new ideas have been incorporated. Unequal length wishbones and coil springs form the basis of the independent suspension, which is assembled on a detachable cross member. This member is rubber-mounted at four points on the longitudinal chassis members.

Rubber bushed pivots carry the pressed steel lower wishbones, while the upper wishbones, also pressings, have screwed pivot bearings. As viewed in plan, the wishbones are trailing at an angle of approximately 25 deg. An anti-roll bar is clamped to the forward arms of the lower wishbones and is, therefore, part of the springing system. Telescopic dampers are carried coaxially with the coil springs.

The road wheels swivel on the vertical links, which have ball attachments to the top wishbones and trunnion fixings to the lower ones. Undoubtedly, the most novel feature of this suspension is the design of the trunnions, which pivot in screwed bushes. A bolt, referred to as a king-pin journal, passes through a boss on the vertical link; the trunnion and a ball thrust bearing are supported by a castellated nut locked with a split pin. Viewed from the front of the car the pin is inclined, like a normal king-pin. Camber and castor adjustment are effected by altering the position of the trunnion bush, which has an eccentric bore. The makers claim that the greatest possible castor angle should be used to ensure effective stabilization at high road speeds. While the ball joint connections between the top wishbones and vertical links do not require maintenance, the lower trunnions and top wishbone inner pivots require attention, with the grease gun, every 600 miles. As on the Volga, ball races are used in the front wheel hubs and these should be repacked each 3,500 miles.

Experience gained, with the Sunbeam Rapier models, in competitions must have proved an invaluable guide when the design of the new Alpine was contemplated. Unequal length wishbones and coil springs are employed and the pivots are set at an 18 deg trail angle. In the laden condition, the wishbones are parallel and the roll-centre is therefore at ground level. An anti-roll bar is bolted to the lower wishbones in a manner such that it becomes part of the normal springing system. Telescopic dampers are carried coaxially within the springs, which give a rate at the road-wheel of 77 lb/in.

The connection between the wishbones and the vertical link on each side is effected by a ball joint at the top and a trunnion at the bottom. These connections, and the screwed pivots, require attention with the grease gun at regular intervals. Wheel camber and castor angles can be adjusted by means of packing plates at the upper wishbone inner pivot. From the laden condition, almost equal bump and rebound movement is provided, the total wheel movement being 5½ in.

Shown for the first time at Earls Court was the Triumph Herald, which has unequal length wishbones and coil springs. The wishbone arms are formed from pressings, and the pivots of the lower ones are very widely spaced. Rubber bushes form the pivots of the upper wishbones,

which are connected by ball joints to the vertical links. A screwed trunnion serves to connect each vertical link to the bottom wishbone, which pivots on nylon bushes. An anti-roll bar is fitted, and a spring-and-damper unit, rubber mounted on the bottom wishbone, completes the suspension system. The coil spring is not, as in normal practice, mounted completely on the damper, but it can be assembled to the vehicle as a unit, since the top spring pan is bolted to a vertical tower on the frame side member. Adjustment of both wheel camber and castor angle is effected, by means of packing pieces, at the lower wishbone pivot brackets.

The ball joint on the vertical link, as well as the nylon bushes, are pre-packed and require no further attention. On assembly, the screwed trunnion is filled with hypoid oil and requires topping up at 12,000 mile intervals. A set-screw seals the hole, into which a nipple is screwed for replenishment purposes.

A relatively firm ride is provided, the spring alone giving a wheel rate of approximately 85 lb/in; for single wheel-movements, the torsion bar increases this to 100 lb/in. The bump rubbers are inside the damper unit, and allow movements of 3½ in to the bump and 3⅛ in to the rebound position. A high roll-centre, 6½ in when two persons are carried, has been found to give good cornering characteristics, and this fact has been appreciated and commented on by all experienced drivers who have tried this car.

STEERING

Emphasis on Design for Small Turning Circles, to Cater for Operation in Dense Traffic

WITH traffic density and parking problems increasing rapidly, and the consequent need for greater manoeuvreability, there is no doubt that a small turning circle is a real necessity. One British manufacturer of quantity-produced cars has obviously given this matter serious consideration during the evolution of the latest model. On two other new small cars, employing identical chassis components, the opportunity for following suit has been lost by the adoption of front wheel drive, a layout that has been dictated by other practical requirements. Rack-and-pinion operation is ideally suited to a steering layout requiring substantial track rod movements, and it obviates the need for resorting to the adoption of a variable steering ratio. Firms not previously interested in the manufacture of steering units are entering this field. The possibility of eliminating greasing points from the steering linkage is now receiving more serious attention than hitherto, and one manufacturer has already developed joints which do not require periodic attention.

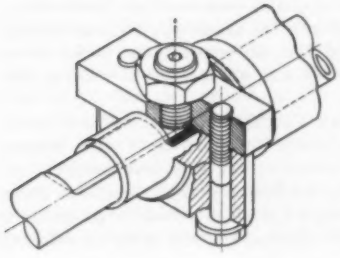
A rack-and-pinion steering unit is fitted to the new A.C. Greyhound. It is mounted on a cross-tube in front of the engine, and is of a type in current production for other vehicles, so its cost is relatively low. Rack-and-pinion steering is also used on the Austin Seven and Morris Mini-Minor models. For these applications a turning circle of about 31 ft has been chosen. Since the front axle has to receive the driving half-shafts, the universal joints obviously limit the angle through which the road wheels may be turned; however, an angle of 32 deg is obtainable on the wheel on the inner side of the vehicle during a turn; the equivalent angle of the outer wheel is 27 deg. All-metal joints are used in the steering linkage and, of course, require periodic lubrication.

Cam-and-peg steering units are employed, in conjunction with an orthodox slave lever and three-piece track rod assembly, on the Austin A40, A55 and A99 cars. On the A40 model, nylon bearings connect the intermediate portion of the track rod to the drop arm and slave lever, but the other joints are of the all-metal type requiring routine lubrication. The relative wheel angles on lock approach those of an Ackerman layout, but the turning circles of the A40 and A55 saloons are not particularly good when compared with the Seven and certain other new family cars. On the A99, a wheel angle of 37 deg is obtained, giving a turning circle of 38 ft 8 in, which is good in view of the 9 ft wheelbase.

A rack-and-pinion steering gear is housed among the maze of pipes and chassis tubes on the Cooper racing car. The pinion is approximately mid-way between the ends of the rack housing, and the track rod joints at each end of the rack are at about the same height as the pivots of the lower wishbones. On the new Daimler SP250 sports car, a Cam Gears cam-and-peg steering gear is used. The box is bolted directly to the outer face of one chassis frame side member, and the slave lever is similarly mounted on the other side member. A crank in the middle portion of the three-piece track rod enables it to clear the engine fan drive shaft; rubber bushed joints are employed at the connections of this portion with the drop arm and slave lever. The stampings that house these rubber bushes are extended outward to carry the inboard pivots of the track rod outer portions, thus ensuring that these joints are at the correct height relative to the geometry of the road wheel movement. Lock stops are provided on the swivel member trunnions; wheel angles of 34½ deg inner and 31½ deg outer are obtainable, giving a turning circle of approximately 33 ft.

A Burman recirculating-ball steering gear is employed on the new Ford Anglia. It is bolted to the inner face of the body longitudinal member, and its drop arm is connected by a forged rod to the similarly mounted slave lever. The inboard joints of the outer portions of the divided track rod are attached to the forging at positions appropriate to the suspension geometry. Both tie rods are adjustable, for wheel alignment, and all ball joints and the slave lever pivot require periodic lubrication.

As is the case with their suspension systems, the steering gear of the Russian models exhibited bears a remarkable likeness to well-known British designs. Internally, the steering gear on the Volga car resembles the Marles unit. The steering box is bolted to the frame longitudinal member, and a slave lever assembly is bolted to the corresponding frame member on the other side. A three-piece track rod connects the two levers. Although universal joints are essential only on the outer sections, all six joints are identical. The inner joints of the outboard portions of the track rod are at the true centres of swing of the joints



An interesting feature of the Herald car is the steering column layout. The column is divided and the portions clamped together, an arrangement that permits adjustment, and telescoping in the event of a heavy impact

on the steering arms, as controlled by the suspension geometry, and, consequently, suspension movement does not result in any steering action.

A manually operated lubrication system, similar to that described in the section on front suspension serves the joints on each side. The drop arm and slave lever each incorporate a boss on one side for the attachment of the inner joints of the track rod outer portions, and these are supplied with oil through a flexible pipe. A soldered-in connecting pipe joins the two adjacent bosses on each lever, and the steering arm joints are fed by tubes clipped to the track rod outer sections. A separate pipe from the metering valve chamber is connected directly to the slave lever pivot. This pivot is of robust proportions, and there is one screwed type bearing in each end of the lever boss. The threaded pin is drilled, to lead the lubricant to the lower bush, and it is secured by setscrews to the lever boss, which is split on the side opposite to the lever.

On the Moskvitch saloon, with left-hand drive, a worm-and-roller type of steering gear is employed. The box is bolted to a longitudinal member of the frame structure. A drag link connects the drop arm directly to the right-hand steering arm, while the other steering arm is coupled to a ball joint housing situated on the drag link, close to the drop arm ball joint. All the joints are fitted with grease nipples, which should receive attention every 600 miles. It is apparent that the steering geometry is far from ideal, but the manufacturers emphasize the need for loading the car to a nominal degree when the track alignment is being checked. Despite this precaution, however, rapid tyre wear may be a problem on this car.

On the new Sunbeam Alpine, the steering connections across the vehicle have to be behind the engine, because of the forward position of the engine and the use of a semi-trailing wishbone layout for the suspension. A Burman recirculating-ball type steering gear and a slave lever assembly are bolted to the body side members, with packing pieces interposed between them and their seatings. The drop arm and slave lever are double ended, their rear ends being connected by the medial portion of the three-piece track rod. Adjustable outer portions connect the forward ends of the arms to the rearward pointing steering arms. To avoid flexibility in the steering mechanism, the levers are of generous proportions. Two Clevite bushes carry the slave lever shaft. The steering geometry approaches Ackerman, and a turning circle of 34 ft is achieved with a road wheel angle of 32½ deg.

A rack-and-pinion steering gear, of Alford and Alder manufacture, is fitted to the Triumph Herald. The gear teeth are cut at the end of the rack and these form the lock stops of the mechanism. This unit is mounted in two blocks, one on each side, and a peg locates it in one of them. U-bolts secure it to the chassis bracket. The blocks have an additional function in that small extensions on them limit forward movement of the engine on its mounting.

In view of the increasing severity of the problem of parking, the Triumph Co. decided that the turning circle of the Herald should be really small. In fact, this car, with a wheelbase of 7 ft 7½ in, has a turning circle as good as that of a London taxi. Adjustable rods connect the rack to the steering arms. Hardened ball pins in the universal joints seat in nylon cups and require no lubrication. The rack-and-pinion unit is packed with grease and requires attention approximately once each year.

Another outstanding feature of the design is the adjustable steering column, on which a 4 in variation in length can be obtained. The clamp securing together the two portions of the divided column is designed to allow the steering wheel and upper portion of the column to telescope if the driver is thrown forward as a result of an impact. Obviously, the column should not be too easily moved, and a simple but effective means is employed to ensure a minimum tolerance of load required to move it. The layout is shown in one of the accompanying illustrations. The friction screw is tightened down, with a standard Allen key, on to the flat formed on the inner column, and is then locked in position. The torque applied to the screw is said to be about 4 lb-ft, provided the key is properly used.

BRAKES

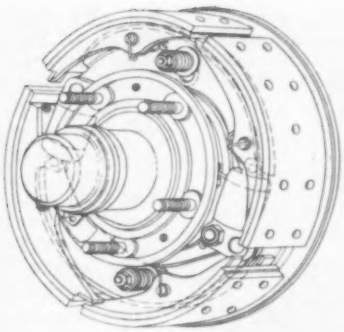
Few Important Changes in Designs; Disc Brakes Standardized on More Medium- and High-Power Cars; Additional Features for Safer Driving

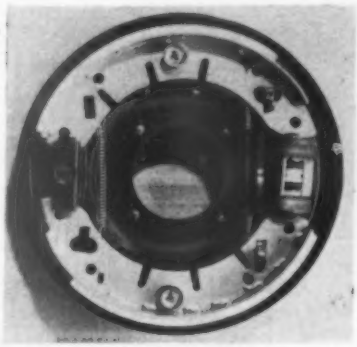
DEVELOPMENTS in braking equipment during the last twelve months have again been mainly confined to improvement of existing designs. With the rapid and considerable increase in the number of vehicles on our inadequate road system, calling for more frequent deceleration and stopping and encouraging many drivers to take advantage of their car's speed capabilities when able to do so, braking efficiency and reliability are becoming progressively of greater importance. Both chassis and braking equipment manufacturers have kept well abreast of requirements, and their latest designs indicate, without drastic changes, further efforts to maintain the necessary standard of safety while recognizing the tendency towards increased engine power and speed performance.

So far as British cars at Earls Court are concerned, the most important modification in the majority of cases is a change-over from drum to disc braking as standard equipment or, in a few instances, as an optional extra. The disc-brake equipped cars exhibited, however, were greatly outnumbered by those having the drum type; they were mainly confined to the medium- and high-powered machines, with disc brakes on only the front wheels, and racing and sports models for which four-wheel disc braking is accepted practice. In some instances, disc braking is the direct result of increase in engine power. Drum brakes continue to be universally used for cars of about 1,000 cm^3 engine swept volume and under.

The chief factor discouraging a general swing over to disc brakes appears still to be higher cost, which is likely to persist until an increased demand leads to production on a scale large enough to justify a more competitive price level. This particularly applies to the smaller cars for which drum brakes on all wheels adequately meet all needs under present-day traffic conditions. There also remains the problem of hand brake application to the disc to hold a vehicle on very steep gradients, without excessive pressure and driver effort, as satisfactorily achieved with the drum type without adding to unsprung weight. For this the transmission brake offers a possible though probably not an acceptable solution for touring cars.

On the latest Bentley Continental, front wheel drum brake performance has been improved by a new system superseding the previous two leading shoe arrangement. As before, application is by two hydraulic cylinders, but these operate two shoe carriers, on each of which is mounted a pair of half-shoes. The latter are fitted with the friction





Above, left: The new Lockheed P.M. type rear disc brake, with handbrake attachment; the outboard cylinder is housed in a bolted-on cover plate. Above, middle: To increase the lining area, the 1960 Bentley Continental has four-shoe front brakes. Above, right: A typical Lockheed rear brake assembly for a 9 in diameter drum. Below, right: The current Dunlop rear disc brake, of the type now fitted to a number of high-performance cars

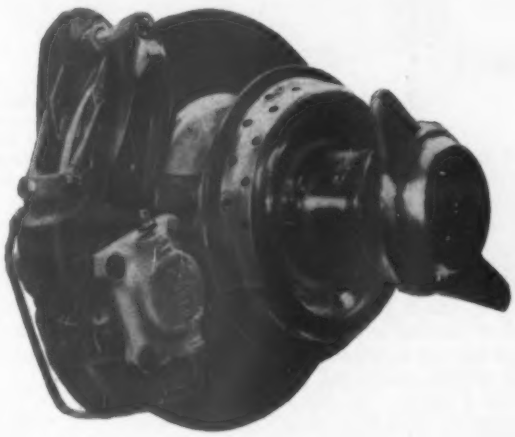
material and are formed with internal lugs by which they are pivoted and free to rock on the carriers. With this modification, not only is the shoe area of contact with the drum increased, but a more evenly distributed and effective shoe pressure obtained. For the rear brakes the two leading and trailing shoe arrangement is retained.

A new range of Lockheed leading and trailing shoe drum brakes made its first appearance at Earls Court. It comprises five sizes, from 7 in × 1¼ in to 10 in × 2¼ in, the smallest of which is fitted to the new Morris Mini-Minor and Austin Seven cars.

The T-section steel shoes are of the floating anchor type, the whole set of eight being identical, and thus interchangeable. Those of the same size in the two leading shoe range are also interchangeable with them. Hand brake mechanical operation is effected by means of a strut and pivot mechanism, and the hand brake lever connections may be arranged either transversely or parallel to the backplate. The backplate of the smallest brake consists of two steel pressings welded together. Both are flanged so that the inner one, which is of smaller diameter, provides additional protection against entry of mud and water.

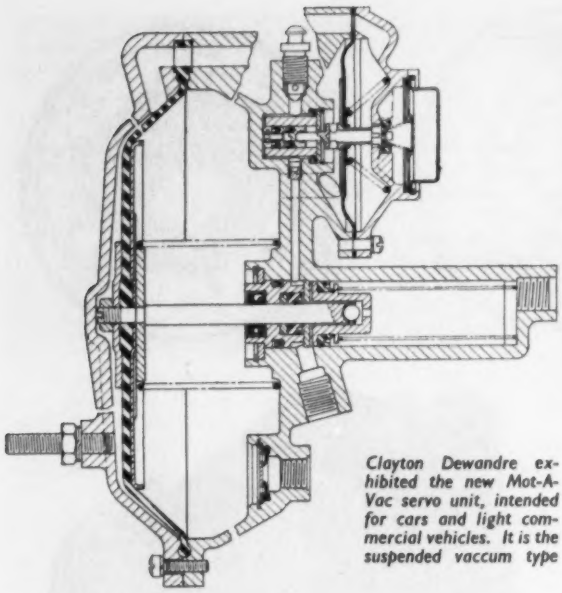
A new Lockheed open calliper type of disc brake has also been introduced and has been fitted to the Alvis 3-litre, Wolseley 6/99, Austin A99, M.G. and Sunbeam Rapier cars. To provide adequate rigidity, the principal component of the calliper assembly is a solid bridge member surmounting the disc and embodying one of the two cylinders; a cover member, secured to it by two bolts, contains the other cylinder. Oval-shape friction pads, bonded to pressure plates, can be quickly withdrawn through the calliper aperture after removal of a pair of locating pins and anti-rattle springs. Automatic pad adjustment is provided by the well-known Lockheed fall-back device. The rear brake calliper is formed with lugs for attachment of a three-lever hand-brake mechanism that applies tapered pads near the outer edge of the disc.

Few changes have been made in the designs of the Girling disc brakes. The new rear calliper for the Daimler 2½-litre sports model is, like others in the Girling range, of the split type. On all models, the friction pads are located and retained by two pins, which can be more quickly removed than the keeper plates previously used. The bleed-screws are now fitted inboard, and are more easily accessible with the wheel in position than they were, as previously fitted, in the outboard position. This is an important improvement for quantity production of cars, where the wheels are in position before the bleeding operation is carried out.



The latest Clayton Dewandre product is a particularly simple and inexpensive power assistance unit for use with the hydraulic brake equipment of cars and light commercial vehicles. It is the new Mot-A-Vac suspended vacuum hydraulic servo, which is a compact unit weighing only about 6 lb. Installation can be easily and quickly effected. The unit is supplied as a complete and almost universally applicable kit that includes support and steady brackets, rubber hose, two 6 ft lengths of steel tubing, banjo and other connections, intake manifold connection with branch pipe for additional services. So simple are the fitting instructions that many car owners should be able to mount the servo themselves: it is necessary to make connections to the two brake cylinders and inlet manifold.

This unit is self-contained, with no external rods or levers. It consists of a power chamber; a hydraulically actuated valve controlling the balance of vacuum and atmosphere; a valve chamber; and an integrally cast hydraulic cylinder connected to the master and wheel brake cylinders. The power chamber contains a diaphragm, to both sides of which vacuum is normally applied and which, through the medium of a push-rod, operates a hollow piston in the hydraulic cylinder. With pedal pressures up to 8 lb, the hydraulic fluid passes through an aperture in the piston direct to the wheel cylinders, lightly applying the brakes. With increased pedal pressures, fluid is by-passed to the control valve, which contains a small suspended vacuum diaphragm operating a short piston, subject to the hydraulic pressure, and an air inlet valve. Increased hydraulic pressure moves the diaphragm and piston, opening the air valve and admitting air to one side of the diaphragm, so that the latter tends to return to its normal position and close the air valve, thereby exerting a counter pressure, which is felt at the brake pedal. Air is admitted also to one side of the power chamber diaphragm so that it moves the push-rod, which then seals



Clayton Dewandre exhibited the new Mot-A-Vac servo unit, intended for cars and light commercial vehicles. It is the suspended vaccum type

the aperture in the piston in the hydraulic cylinder. Further movement applies pressure to the fluid in the cylinder, and this is added to that exerted by the pedal. Progressive power braking is obtained at all times, with slightly more than half the unassisted pedal effort, and should the vacuum fail, normal unassisted braking remains unaffected.

On a number of cars exhibited, additions to the brake equipment have been made for greater safety. For example, the new pressure regulating valve is included in the Lockheed brake equipment of B.M.C. range, including the Austin Seven, Morris Mini-Minor, Austin A99, and Wolseley 6/99. Its function is to allow the rear brakes to have their maximum retarding effect under normal conditions, but preventing locking of the rear wheels when the hydraulic pressure applied exceeds a predetermined figure.

The valve has an inlet connection for the main brake line and two outlets to which the rear brake pipes are connected. It contains a simple spring-loaded plunger acted upon by the main line pressure. This plunger is held open against the main line pressure by a compression spring, the strength of which is made to suit the requirements of each car. When the main line pressure exceeds that exerted by the spring, the plunger is moved to shut off the pressure to the rear brakes, so that they remain applied at the pre-set pressure. When the pedal is released again, the valve re-opens and brake line pressure falls with that in the main line. For applications with pressures less than the spring setting, the valve remains open so that the rear and front brake pressures are equal, as would be the case if no pressure regulating valve were fitted.

Another safety feature—on, for example, the Austin A99 and Princess 3-litre cars equipped with Lockheed vacuum servo-assisted brakes—is a warning lamp which indicates to the driver if the vacuum in the reservoir falls to an inadequate value. In each of these vehicles, the reservoir is under the near-side front wing, with a short vacuum pipe connection to the servo. To the end of a branch extension of the vacuum line is fitted a diaphragm-operated electric switch, having contacts held apart by a spring, and wire connections to battery and warning lamp on the dash. Should the vacuum in the reservoir fall to about 4 in, the deflection of the diaphragm closes the contacts in the lamp circuit.

For cars having hydraulic brake equipment, an indication can be given when the fluid in the reservoir falls to a dangerous level. This is done by the Sovy safety indicator fitted, for example, on the Citroën DS19 and Panhard cars. The instrument consists of a float in the reservoir, and it actuates a rod which operates electrical contacts in a screwed cap that can be fitted in place of the standard filler cap. The contacts, of course, are in the circuit of a warning lamp or buzzer on the dash. An extension of the operating rod passes through the cap, so that the fluid level can be checked visually without removing the cap.

A float-operated warning lamp switch is also included in the hydraulic brake equipment of the Jaguar Mk 2. In addition, electric contacts are held closed by the hand brake lever in the applied position so that, when the engine is switched on, a warning light advises the driver not to move off until the hand brake is released.

As a safety measure, particularly for the heavier and faster cars, there is much to be said for the installation of entirely independent hydraulic systems for the front and rear brakes, including separate master cylinders and reservoirs. Such provision is made on very few cars, but included among them are the Bentley Continental, A.C. Greyhound and the new Rolls Royce Phantom V limousine and Silver Cloud II.

The latest caravan designs do not include any important modifications of brake application or control equipment. A slightly modified version of their dual control hydraulic reaction valve has been introduced by Feeny and Johnson Ltd. This has a larger hydraulic piston, of $\frac{3}{4}$ in diameter, for use on commercial vehicles. For diesel-engined vehicles, of the smaller types, fitted with vacuum-assisted braking, the company have also produced a new type E.240 sliding vane exhauster. This is of smaller size than their E.300 model, and can be more easily installed under the bonnet. It is belt-driven, but a similar motor-driven unit is available.

Electrical Equipment and Heaters

Electrically Controlled Automatic Transmission System Adopted as an Optional Extra on Quantity-Produced British Cars

PARTICULARLY noteworthy among the electrical developments at this year's London Show are the Lucas all-glass sealed beam headlamp light units. These can be regarded as a definite advance in minimizing the dazzle problem. Another milestone of progress is the adoption as an optional extra on the Hillman Minx and the Singer Gazelle cars, of the Smith's electrically controlled transmission system. This system was designed for incorporation in the Rootes Easidrive fully automatic transmission. By virtue of its high efficiency, this system serves to bring the benefits of automatic transmission within the range of the popular medium powered cars.

Some interesting developments have also taken place in regard to sparking plug design. These are for improved performance and durability under the exacting conditions in the modern car engine, brought about on the one hand by

intense traffic congestion in large towns and on the other by the high speeds now attainable on the new motorways.

The current designs of generators and starter motors reveal constructional improvements to facilitate production, increase output and, in the case of starter motors, improve pinion engagement. Notable new designs are the Lucas Models C40-1 and C45PV-6 generators giving higher output without any increase in weight, and the Simms concentric starter motor with its solenoid-actuated pinion to provide smoother engagement.

Significant with regard to car generators, is the standardization, on the Chrysler Valiant car, of an alternator instead of a conventional D.C. generator. The ability of the alternator to give a high output at low engine speeds, largely owing to the wider permissible speed range of an alternator as compared with a dynamo, greatly relieves the strain on the battery, especially in heavy traffic, with the heater, windscreen wiper and headlights operating.

With the natural tendency to increase the battery load by the addition of electrical accessories, it is pleasing to note one application in which the current consumption is reduced, even though it may only be by a matter of about 1½ amp. The latest transistorized car radio receivers, of which those manufactured by E. K. Cole Ltd., Philips Electrical Ltd., and S. Smith and Sons (Radiomobile) Ltd., are representative, exemplify not only reduced current consumption but also more compact and less costly designs.

Generators and starter motors

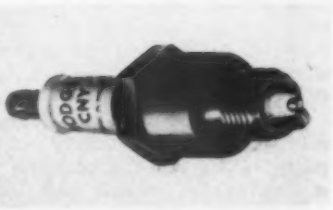
The need for increased generator output on modern cars has been met by Joseph Lucas Ltd., by the introduction of the new C40-1 and C45PV-6 dynamos, giving maximum outputs of 22 and 25 amp respectively on 12 volt systems. Constructional changes, notably the extruded yoke and moulded commutator, have been made to facilitate production and these, together with other design improvements, have resulted in a higher output without any increase of weight relative to the models superseded.

For patrol cars equipped with two-way radio, C.A.V. Ltd. exhibited a 5 in diameter, fully suppressed 12 volt 25 amp output dynamo Model D5LFB-15, together with a suitable control board. For cases where heavy, 24 volt battery loads are involved, it was ascertained that transistor regulated alternators with outputs ranging from 40 to 75 amp are available.

The new Chrysler-built alternator incorporating silicon rectifiers generates appreciably more current at low engine speeds than the conventional dynamo. At medium engine speeds a maximum output of nearly 35 amp, at 12 volts, can be obtained. A remarkable feature of this alternator is that it weighs only 12 lb, or less than 60 per cent of its D.C. counterpart.

Focussing accuracy with the Lucas sealed beam, all-glass lamp units is greater than with the earlier units. The two filaments are shielded

Right: The Lodge Road and Town sparking plugs have a wider heat range than their predecessors.



Below: One of the new transistorised car radio sets is the Ekco CRR903

Simms Motor Units Ltd., also, now make an alternator, for operation in conjunction with a transistor current and voltage regulating system, for marine and other applications. This alternator is a nominal 7 in diameter machine intended for running at twice engine speed and is capable of giving a controlled output of 40 amp at 27 volts from 850 r.p.m. upwards.

New and improved designs of starter motors were exhibited on the Simms Motor Units Ltd. and C.A.V. Ltd. stands. The new Simms 4½ in concentric starter is of the axial type, with two-stage solenoid engagement of the driving pinion. A freewheel is incorporated to safeguard the motor from damage when the engine over-runs the motor. Disengagement of the pinion is effected by spring pressure. The latest version of the C.A.V. 4½ in coaxial type starter motor has a higher power output than the original design.

Lighting

The introduction, for the first time on British cars, of an all-glass sealed beam headlamp light unit by Joseph Lucas Ltd., is undoubtedly an important advance in road vehicle lighting. The much greater accuracy with which the lighting filament can be focussed by the manufacturer in this construction of light unit, as compared with the pre-focus bulb type, results in two notable advantages. First, the setting of the headlights on a vehicle can be a simple mechanical instead of an optical operation; and secondly, the ease and consistency with which the headlights can be aimed will materially minimize the risk of dazzle to oncoming drivers.

In this new light unit a double transverse filament assembly with a filament shield is sealed to the back of the unit and the internally aluminized glass reflector is fused to the front lens in a controlled position. There is no separate bulb, the entire light unit constituting, in effect, a very large bulb.

The first all-glass sealed beam units will be of the 7 in type, fitted as initial equipment, and so great will be the demand for these first units, that it is unlikely that the new design will be available to the general public for many months. Replacing the model F700, which has a rating of 55/44 watt at 12·8 volts, the new light unit will have a rating of 60/45 watt at the same voltage.

Other advantages of the new light unit are as follows. The initial illumination will be maintained over years of service, since there will be no blackening of the glass, which is an inherent defect of the present relatively small bulbs. Both the range and illumination from the main beam on straight

roads will be better. The meeting beam will have greater range and give better illumination along the nearside kerb; there will be improved light distribution immediately ahead of the vehicle and less glaring light above the horizontal to the offside.

Of interest also among the Lucas exhibits, were the new models 5LR and 5FT Ranger auxiliary lamps. These long-range and fog lamps respectively, are distinctive in respect of a vertically mounted bulb, a feature which, without detracting in any way from the light range and distribution, enables a notably shallow design to be produced. In consequence, the risk of damage by the overriders of other cars is greatly diminished.

In a large display of Wipac lighting equipment, including the well-known Penetrac 7 in replacement light units and the pre-focus light set for the Ford Popular models, the new and attractive twin-set, spot and fog lamps, are noteworthy. These lamps are of the same matching design and differ only in the pattern and colour of their lenses. A specially designed bracket facilitates fitting in a variety of positions and also beam alignment before finally tightening. New, also, in the range of Wipac products are the Reversa-lite and the heavy duty rear stop-light. Of these two, the former is a pleasing and robust design of lamp, with a rectangular lens giving a wide beam of light, essential for maneouvring at night. The rear stop-lamp is a sturdy and weatherproof unit with a 3½ in diameter by 1¼ in deep lens. A steel back-plate carries the bulb holders, and is covered externally by a resilient plastics moulding, with an annular lip to receive the red lens. This construction dispenses with the need for sealing washers, and also ensures weatherproofing.

Also specifically designed for heavy duty are the new Lumax models CD9 and CF9 driving and fog lamps, shown by Ceag Ltd. These are 5⅛ in lamps of all steel construction cadmium plated for rust-proofing and finished with a high gloss black stoving enamel.

Other interesting lamp exhibits were the Bosch Slim fog lamp, with a 100 deg horizontal beam spread, and the Marchal 7 in asymmetrical light unit, with a filament shield to eliminate back-glare. This latter unit gives a light beam in full conformity with the new European Lighting Code. When going abroad, the changeover from driving on the left to driving on the right is effected simply by rotating the bulb from one marked position to another.

Ignition

New developments in regard to ignition were mainly associated with sparking plug design. For the new AC-Delco Hot-Tip sparking plug with its built-in self-cleaning action, improved peak performance and petrol consumption are claimed. The outstanding features of this new plug are as follows. A deep annular recess in the extremity of the insulator surrounding the central electrode tip provides an air space around the electrode tip and also reduces the section at the nose of the insulator. In the body of the insulator, the Conductaseal, formed by the fusion of copper and glass, ensures the best possible gas-tight centre seal and electrical conduction path.

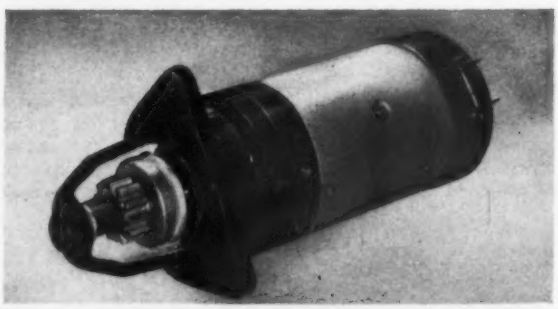
The specially recessed thin section insulator nose is designed so that its temperature is constantly that of the engine cylinder and to burn off deposits as they form, at the same time obviating the risk of pre-ignition. By the Conductaseal, the heat is retained where it is most needed, that is, at the hot tip. A large space between the shell and the insulator also allows the swirl of hot gases to clear away any fouling deposits.

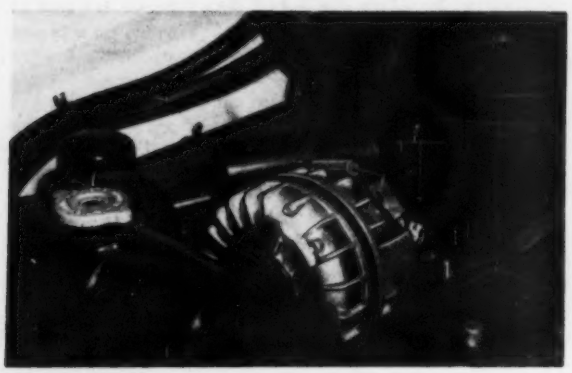
With the object of providing a more rust-resistant and at the same time brighter finish, Champion sparking plugs will in the future have a zinc-plated, silver colour finish, instead of the customary black. The standardization of this finish for all types of plug will be effected progressively, but in the first instance will be applied to the main production types.

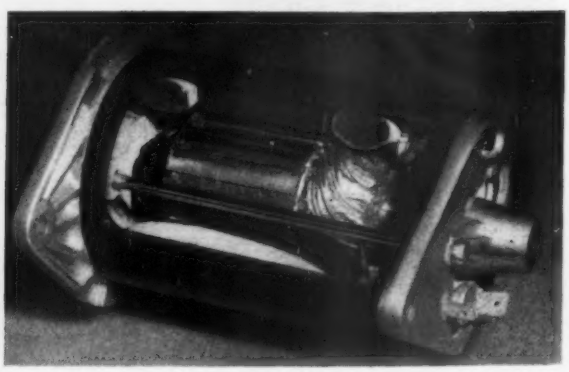
For some years past, K.L.G. racing plugs have been of the non-detachable pattern, to ensure the requisite gas sealing under the extreme operating conditions of racing-car engines. The non-detachable type of plug is now being standardized for production sparking plugs, and the insulator will be sealed into the body by the same hot crimping process that has proved so satisfactory for racing purposes.

By the recent introduction of their Road and Town range of sparking plugs, Lodge Plugs Ltd. claim to give motorists a unit which will be hot enough to resist fouling in heavy town traffic and cool enough to prevent pre-ignition on the open road when high speeds are maintained. A characteristic feature of this range of plugs is an extended insulator nose, near the central electrode tip. The extended nose provides a heat shield for the electrode.

Where the nature of motoring is such that engine tempera-







Above: The new Simms 4½ in starter motor embodies two-stage engagement of the pinion. Below: A feature of the Plymouth Valiant is the alternator. Right: The Lucas C40-1 generator is of improved design

tures remain fairly constant, fuel deposits on the insulator nose are not ordinarily of serious consequence, until they become heavy enough to give rise to tracking. This normally takes a long time and the trouble can generally be remedied by cleaning. If, however, a car with accumulated deposits on the plug insulators is suddenly subjected to sustained high speed running, the temperature rise results in a change in the chemical composition of the deposits, and forms a glaze over which tracking may readily occur, with consequent misfiring or even complete plug failure. With the new design of plug, the fuel deposits are burnt off as soon as they form and tracking does not develop. The overall advantages of the new plug design are stated to be resistance to fouling, more economical fuel consumption, and smoother running under all conditions at all speeds.

Realizing the trouble old high-tension leads can cause motorists, Lodge Plugs Ltd. have introduced sets of pre-cut H.T. leads suitable for four and six-cylinder engines. These are made up from the best quality oil, petrol, and moisture resistant p.v.c. cable and are neatly packed in sets, numbered 1, 2, 3 and 4. The first two cover the requirements of four-cylinder cars and sets 3 and 4 the six-cylinder range of cars. Complete with connectors, these are handy and quite inexpensive replacements that will be highly useful to owners of cars that have been in service for some time.

Batteries and battery chargers

The practice of marketing two grades of battery, generally on the basis of one or two years guarantee period, would appear to be the policy of most battery manufacturers. Both grades can be relied upon for satisfactory service and the choice of grade will, of course, depend largely upon the nature and duration of the service to be demanded of the battery. A newcomer to the economy class of battery is the Oldham Lively O battery.

A new battery with the two year guarantee is the Dagenite Sheerline battery, manufactured by Pritchett and Gold and E.P.S. Co. Ltd. This battery is noteworthy, in particular, for a one-piece lid which, as a single component, effects complete sealing of the entire battery. The flat, streamlined top renders cleaning and the removal of moisture easy and the risk of corrosion is greatly reduced by the absence of unnecessarily exposed metal.

The S range of the Lucas King of the Road batteries has this year been extended to include the SL7 battery, suitable for cars fitted with a low type, seven-plate battery, and the S9 for cars fitted with the standard nine-plate battery. Like the S7, shown for the first time last year, these will have the easy-to-clean casing top and the attractively styled vent covers.

Car owners requiring an inexpensive and easy-to-use battery charging unit, for occasional overnight operation to ensure easy starting, will find the new Wipac Chargeomobile of interest. It is no larger than a standard ignition coil and can be fitted easily and permanently to the car, for which purpose a suitable bracket is provided. All that is necessary to put the Chargeomobile into operation is to connect up two leads to the battery terminals and make a further connection to the mains supply. When the mains supply is switched on, the battery will be automatically charged at a rate of 1 to 1½ amp. A two-pin changeover plug incorporating a safety fuse, enables 6 or 12 volt charging to be selected.

In addition to a new model in the range of Davenset Home Battery Chargers, Partridge, Wilson and Co. Ltd. also exhibited a new range of commercial chargers. The use of germanium rectifiers has effected a considerable reduction in the size of these units.

A new model of one of the earliest and best known battery chargers was displayed on the Siemens Edison Swan Ltd. stand. This is the Ediswan Tungar 5 amp, 6 or 12 volt charger for home and commercial use. In its latest form, rectification is effected by a selenium metal rectifier and is supplied complete with ammeter, fuse, A.C. and D.C. leads and battery clips.

A matched pair of auxiliary driving and fog lamps forms a useful adjunct to the headlamps. These are the Lucas 5LR and 5FT Ranger paired lamps

Electrical control of automatic transmission

The magnetic powder coupling transmission unit developed by Smith's Motor Accessory Division and exhibited at last year's Show, has been taken a stage further by its incorporation in the Rootes Easidrive system, which is now an optional extra on the Hillman Minx and Singer Gazelle cars. The outstanding features of this system of automatic transmission are: the relative simplicity of the design, which renders servicing easy; and its efficiency, which enables it to be applied satisfactorily to medium powered cars.

Since this system has been described in the November 1958 issue of *Automobile Engineer*, it will suffice to say that when the steering column selector lever is moved to the driving position 'D', with engine running, depression of the accelerator pedal will start the car moving and gear changing will be effected automatically according to road speed and engine load. Movement of the selector lever to the intermediate position '2' permits the driver to override the automatic control and hold intermediate gear under, for example, town traffic conditions. Reverse gear operation is effected by moving the selector lever to position 'R'. Automatic gear changing is effected through the medium of a double electro-magnetic clutch; a governor, the speed of which is decided by the road speed; gearshift and throttle solenoids, and a master control unit. When the transmission is in top gear, the current consumption is of the order of 7½ amp.

Speed indicators

As exemplifying a novel development in speed indication, the new K-L Cirscale electronic engine revolution indicator, manufactured by Record Electrical Co. Ltd., for the Key-Leather Co. Ltd., is of interest. It is a revolution indicator requiring no generator and therefore no separate drive, and it is connected in series with the low tension side of the ignition coil. In effect it measures the rate at which spark impulses are generated in the ignition circuit. This rate being directly related to the engine speed, the indicator can be calibrated to read engine r.p.m. The fact that this indicator requires no provision for a drive from the engine makes it attractive to the racing or trials motorist wishing to observe engine speed accurately. A fuller account of

this revolution indicator was given in the August 1959 issue of *Automobile Engineer*.

Another development of interest is the Smith's horizontal scale, or ribbon type, speedometer, shown at the last Motor Show in prototype form; this speedometer is now being tooled by Smith's Motor Accessory Division for production in 1960. Also among the products of Smith's Motor Accessory Division is the latest design of A.C. speedometer. This is a development of the A.C. engine speed indicator already used on Jaguar cars. In the latest version, an A.C. generator of very small dimensions is driven from the gearbox to register miles per hour. Integral with the generator unit, is a battery-energized device for actuating the counter, incorporated with the indicator, to record mileage.

Car radio receivers

During the past year, appreciable progress has been made in the development of low voltage valves and transistors and also in their application to car radio receivers. The normal radio valve is essentially a high voltage device and, for its operation from a battery, requires a power pack comprising vibrator, transformer, and rectifier, to provide the requisite high voltage D.C. supply. Since both the L.V. valve and the transistor will operate directly from the normal car battery, their adoption in car radio receivers dispenses with the power pack. This effects a reduction in size and current consumption, without impairing in any way the sensitivity.

This latest development was well illustrated by the new models exhibited by E. K. Cole Ltd., Philips Electrical Ltd., and Smith's Radiomobile, all of which are very compact designs. From the specifications, these receivers are for use

A sectioned Dagenite Sheerline battery, showing the integral lid

on a 12 volt battery supply and utilize both low voltage valves and transistors. Current consumption of these sets is stated to be of the order of 1¼ amp.

Heating and air conditioning

The Motor Show certainly revealed that the car owner of today has a truly comprehensive choice of well-designed and efficient car heaters. Of those exhibited, a number are original equipment installations, an example of which is the new Ford Anglia car heater, manufactured by Delaney Gallay Ltd., and supplied exclusively to the Ford Motor Co. Ltd. A special feature of this heater is that it provides full-width screen demisting and defrosting. Fresh air

Another transistorised car radio receiver is the Philips model G82VT

A Perspex case reveals the details of the Smiths ribbon-scale speedometer

drawn through vents above the bonnet can be distributed either cold, hot or as a blended mixture. Also supplied as original equipment, in this case to the Standard Motor Co. Ltd., is the new model S.40 heater for the Triumph Herald car. This is a 100 per cent fresh air heater incorporating the Ranco valve, which controls thermostatically the flow of hot water through the heater, to maintain the desired air temperature. New also among the Delaney Gallay products is the Good Companion heater specially designed for easy installation in the Austin Seven and Morris Mini-Minor cars. Also available from retail sources, this is an inexpensive recirculatory heater providing efficient demisting, and whenever necessary, can be switched to full-scale defrosting.

In the range of Key-Leather recirculation heaters are redesigned models, such as the K-L 54 heater with a built-in outlet to pass through the new parcel shelf introduced on the Morris Minor 1,000 car in March 1959; the new Monitor Mk.III recirculation heater with improved shutter control; and the K-L Monsoon heater of circular design with two fans for effective air distribution for heating and demisting. In the fresh air heater class, the K-L 502 heater suitable for a variety of cars has been remodelled, with controls fully matched to the facias of the individual cars.

The large range of Smith's Motor Accessory Division heaters consist of fresh air and recirculatory types, suitable for most makes of car. For these items a new complement of demister and accessory packs has become available.

Bodywork Review

It would not have been possible to cover all the developments revealed by the 1959 London Motor Show in this Review issue without serious curtailment of the various sections. Consequently, as last year, the bodywork review has been held over, for publication in the December issue. For added clarity, this review will be sub-divided into two sections, one on quantity-produced bodies and the other dealing with the interesting features of high-quality custom-built coachwork.

Among the interesting features discussed in the first section are the slight trend away from full unitary construction, styling changes, and the improvements made in trim and insulation. Although relatively few firms are now engaged in the manufacture of specialist coachwork, the standard of craftsmanship does not decline.

'Brobdingnagian or Lilliputian?

It is improbable that Dean Swift had any thoughts about ball bearings in his curious romancings, but he would, we believe, appreciate the well-balanced design and fine finish of both our big and little fellows. We have made bearings as large as 5' 0" diameter to support a locomotive turntable whilst their tiny counterparts, some as small as 3mm, diameter, may be used on a very high speed dental drill, or perhaps for an instrument where the need is not for speed but extremely sensitive motion. These Lilliputians of engineering are held to B.S.I. limits of accuracy or to the American specifications ABEC 3, 5 or 7.

HOFFMANN

PRECISION MINIATURE
BALL BEARINGS

THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX

MAXICUT

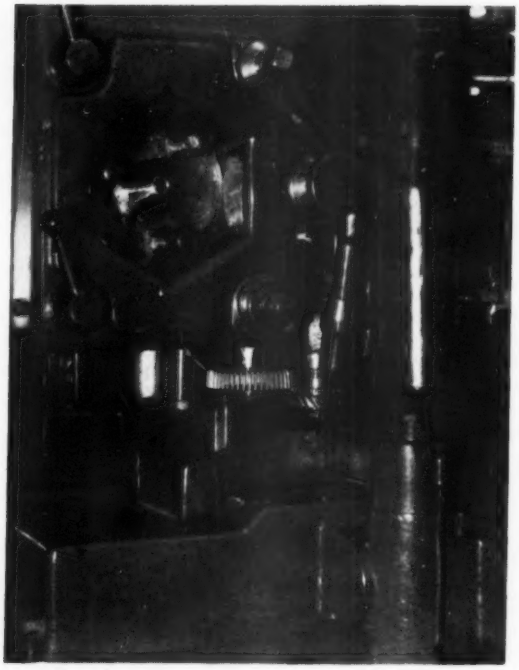
Photographs by kind permission of Ford Motor Company, Ltd., Dagenham

No. 2A
Gear Shaping Machines
with Automatic loading

These Drummond Gear Shapers can now be supplied with automatic loading equipment for the mass production of specific types of gears. When operated in conjunction with conveyor systems, gear production becomes a completely automatic process.

The illustration above shows a line of Maxicut machines installed for high output production of automobile gears and in the close-up view gear blanks can be seen stacked in the tubular type magazine. From this magazine a slider type feeder loads the blank on the work spindle and displaces the machined component into an exit chute. A push button panel at the left of the machine incorporates switch controls for hand or automatic operation, also controls to repeat or not-to-repeat the cycle. The indicator light panel on top of the machine shows whether all functions are operating correctly or not.

Write to-day for full details of Drummond Maxicut Gear Shapers for high speed accurate gear production.



This view shows the slider type feeder arrangement and magazine containing gear blanks.

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D331

ASQUITH

UNIT TYPE MACHINES

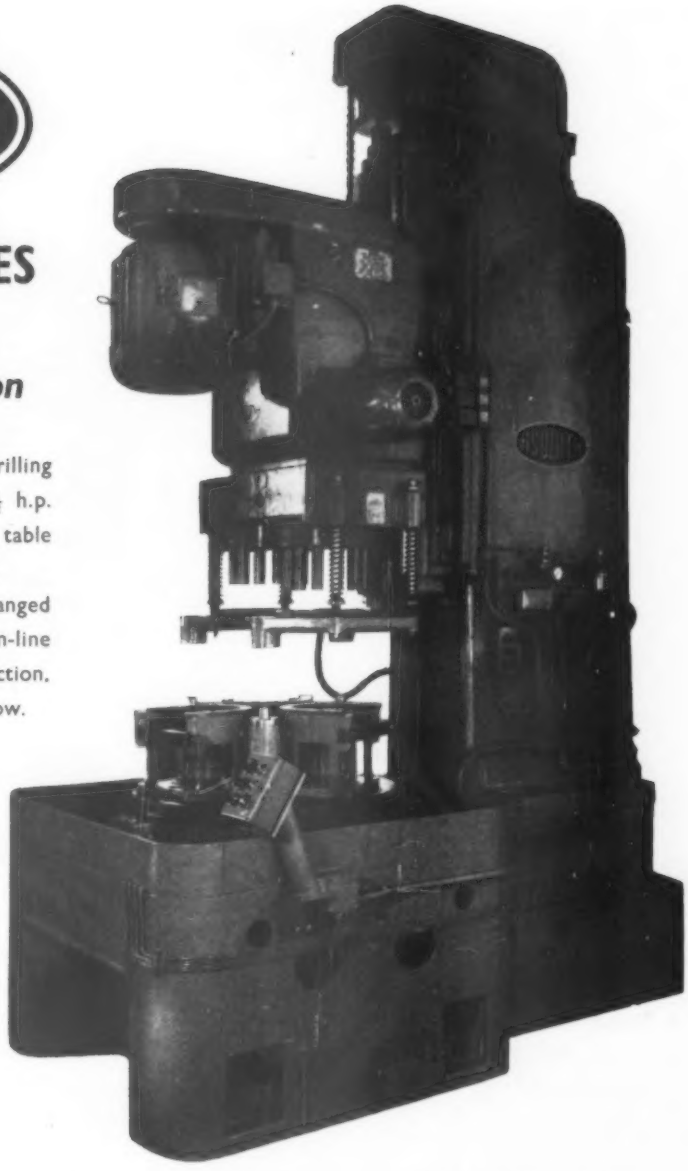
fully engineered for high-output production

The example opposite is a 3-station machine for drilling and reaming operations and incorporates a 7½ h.p. screw unit. The 36 in. diameter hand indexing table is provided with air lift and automatic clamping.

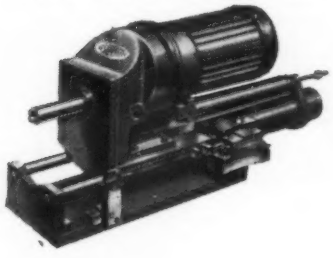
Asquith Units from ½ h.p. upwards can be arranged as individual, multi-way, rotary transfer and in-line transfer machines for fast, automatic production. Some of the unit heads available are shown below.

If you require large-quantity production of components at present produced on several machines, it will be worth investigating the possibility of machining them on an Asquith Unit Type Machine. Write today for details of the range of unit equipment or ask for a specialist to discuss your problem.

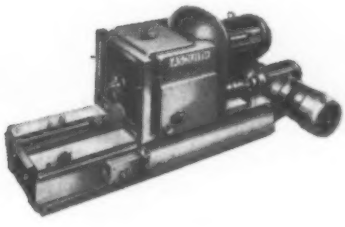
WILLIAM ASQUITH LTD.
HALIFAX · ENGLAND



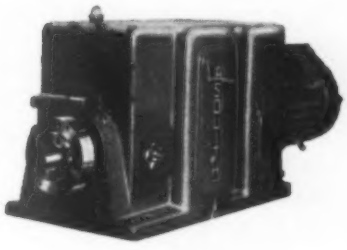
½ H.P. AIR HYDRAULIC DRILLING UNIT



3/5 H.P. SCREW FEED UNIT



HORIZONTAL STATIC MILLING UNIT



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A302

QD...Q&A

Q What exactly do you mean by QD?

D It's a piston for re-vitalising tired engines.

Q Tired?

D After twenty or thirty thousand miles, especially on heavy duty work, most engines tire a little. Tiring is expensive. Your accounts are showing that several of your vehicles are heavy on oil. Your drivers are complaining of low power and are taking longer over their journeys. Fundamentally, that's largely due to cylinder wear.

Q In other words, you think I need new pistons?

D Probably. It depends upon the amount of wear involved. It is possible that the trouble can be cured with Duaflex alone.

Q Duaflex?

D The D part of QD. When piston wear is not excessive you can fit Duaflex Rings to existing pistons to compensate for cylinder wear, restore power, cut oil consumption, and give thousands more miles of lively performance. All for about a sixth of the cost of a replacement engine.

Q And if the pistons are badly worn?

D Then new QD pistons are the answer, complete with Duaflex and Quickseat Top Rings. Your service engineer can determine the best course after measuring the bores and pistons. You can rely on these products curing the trouble. Wellworthy have been specialising in this field almost since motoring first began. **Q.E.D.**

If you have got vehicles in your fleet running up your lube oil bills, heavy on fuel and doing far too much low gear work, fit QD. Write now for literature and address of nearest Stockist to Dept. A10

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or
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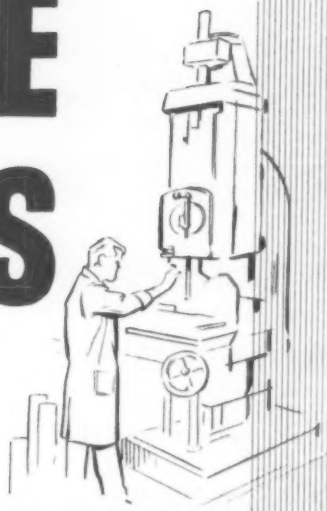

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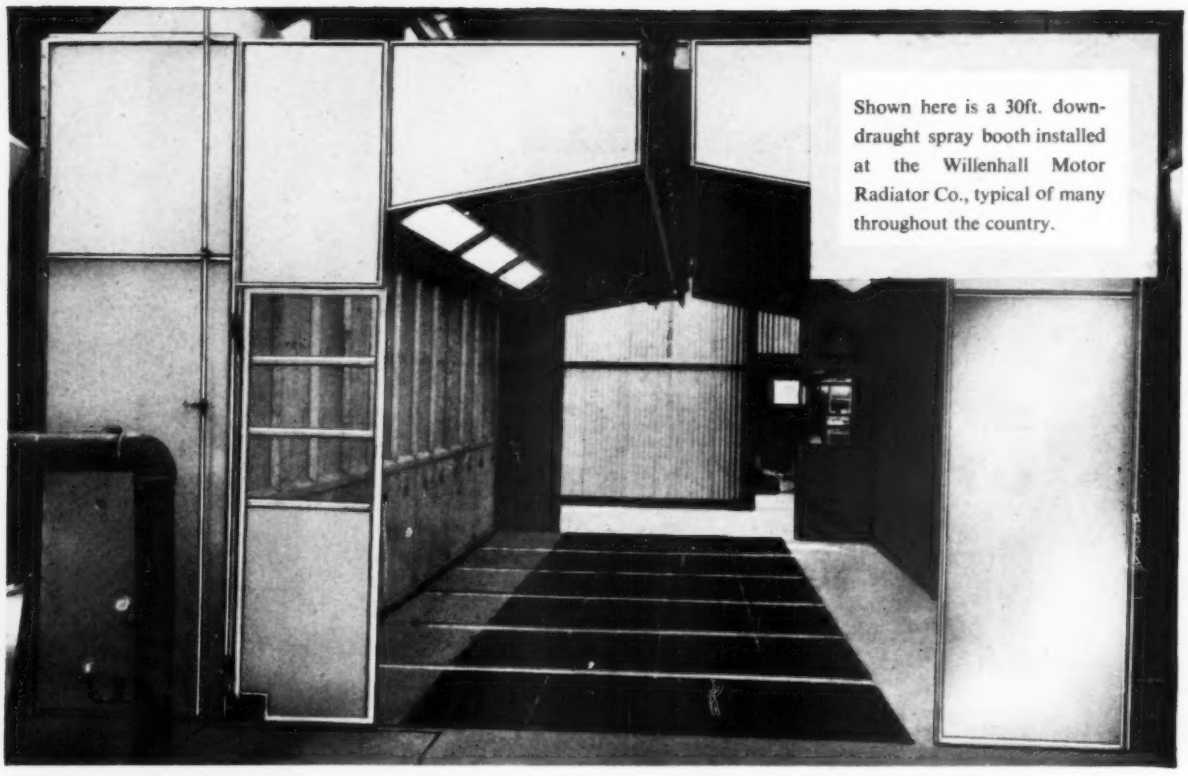


Shown here is a 30ft. down-draught spray booth installed at the Willenhall Motor Radiator Co., typical of many throughout the country.

A.I.D SPRAY BOOTHS ARE SPECIALLY TAILORED TO YOUR REQUIREMENTS

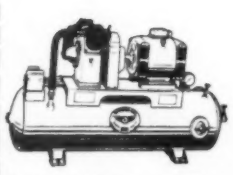
What do you want from a spray booth?

Basically, well finished products at low cost, because the quality of finish and the price vitally affect the saleability of your goods.

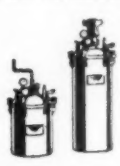
So you need operating efficiency, flexibility to handle varying production batches, reliability, ease of maintenance.

That is why you must have AID experience, AID engineering and brilliant AID design—all of which can only be found at AID. One of our technical representatives will be happy to advise on the installation of spray booths tailored to suit your needs, without obligation naturally.

Model 50B Two-stage semi-automatic compressor.



The 200/2 Two-stage fully automatic air compressor.



AID Pressure feed containers.

The AID model 27 gun.

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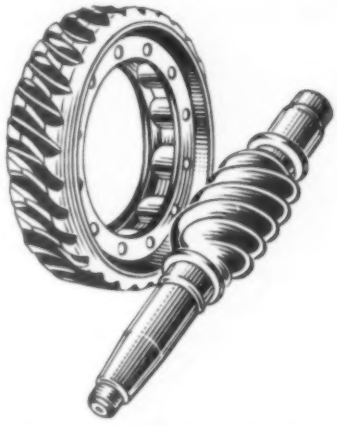

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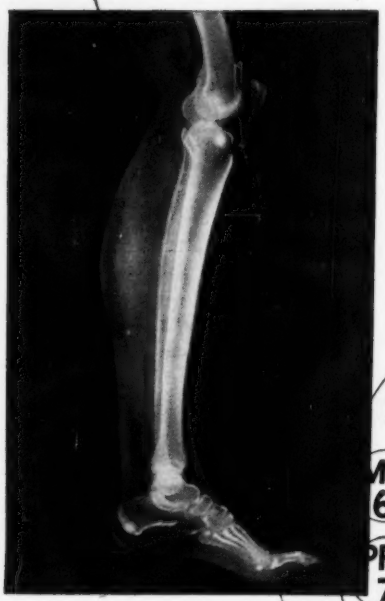
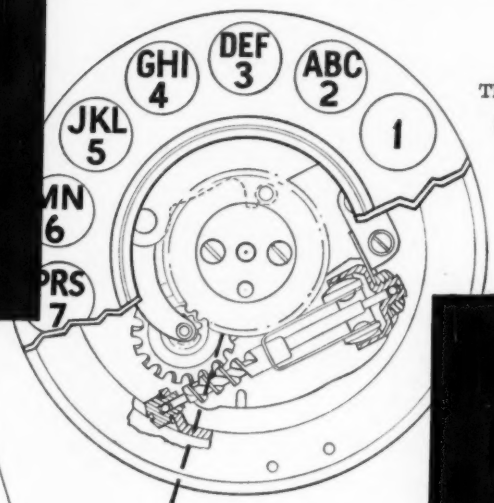
CRC. 199

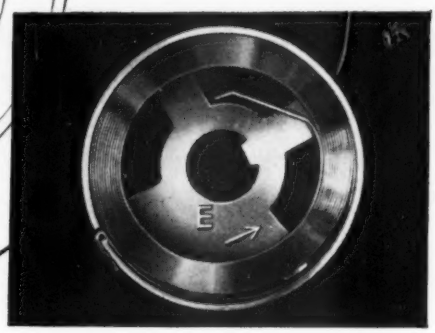
Vital links in controlled movement



A body needs muscles to control movement in very much the same way as a mechanism needs springs. These vital links take the stress and strain of every day rigorous use — nature provides the muscles . . . SALTER provides the springs. Two centuries of experience and development in the manufacture of springs of every type have enabled us to keep ahead of the ever-changing requirements of industry.



The applications for SALTER springs are wide and varied — from heavy machinery to finely balanced instruments.



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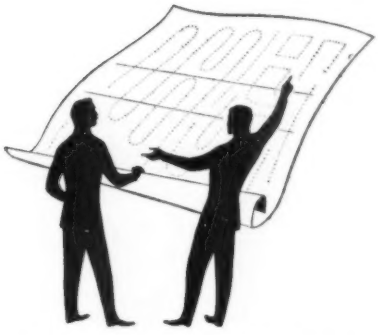

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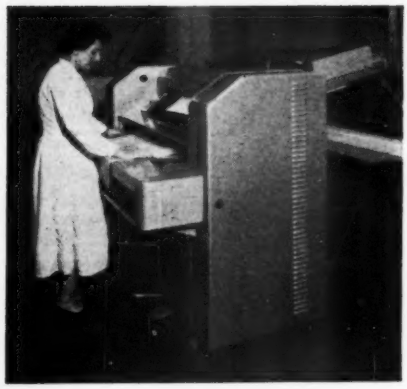

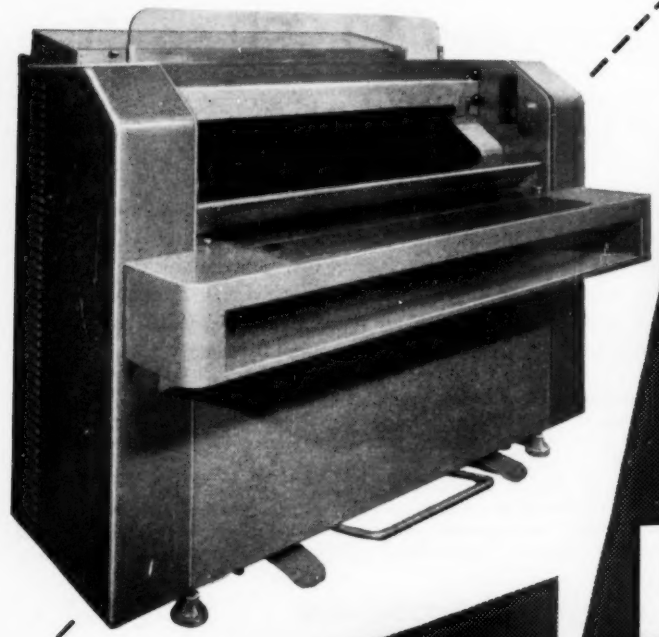

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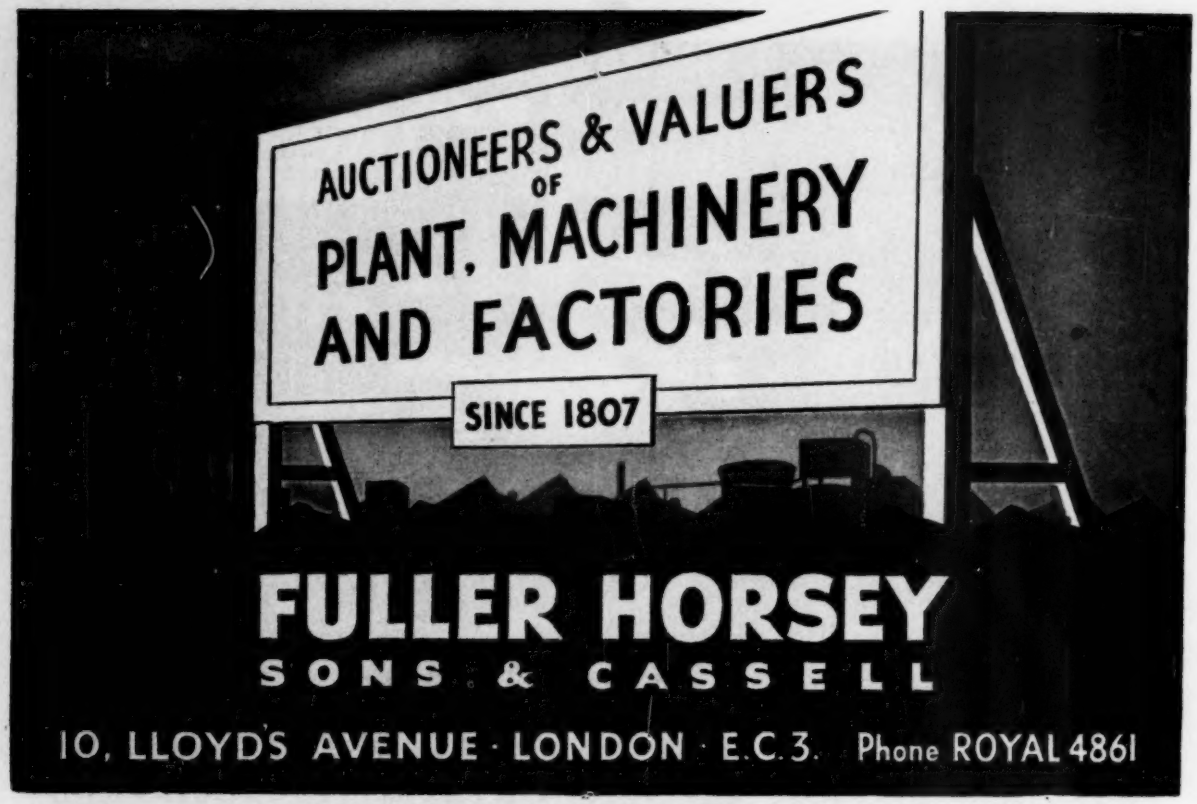
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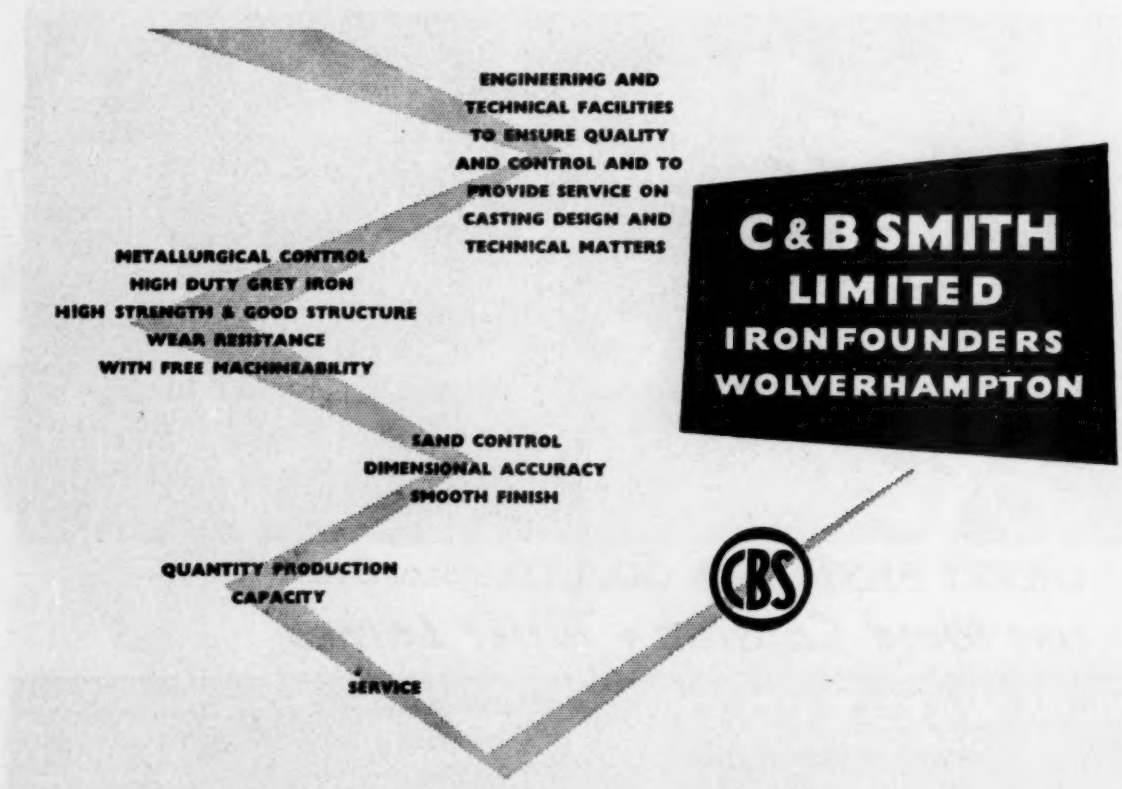
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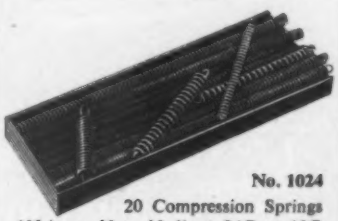

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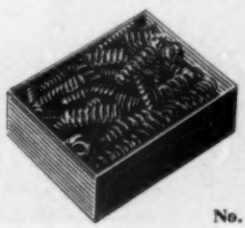
20 Compression Springs 12" long. ½" to ½" diam. 24G to 18G suitable for cutting into shorter lengths; and 30 Expansion 1½" to 12" long. ⅛" to ½" diam., 22G to 16G. **24/- each.**



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Extra Light Compression, 1 gross Assorted, ¼" to ⅛" diam. ½" to 2½" long. 27 to 19 S.W.G. **15/- each.**

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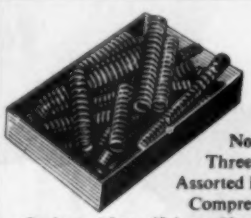
1 foot lengths Expansion Springs suitable for cutting into shorter lengths. Assorted diameters from ½" to ½" and 24 to 16 S.W.G. **7/6 per box containing 1 dozen lengths.**

No. 1200
Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **13/6.**



No. 760
Three doz. Assorted Light Compression Springs. 1" to 4" long 22 to 18 S.W.G. ½" to ½" diam. **6/6 each.**

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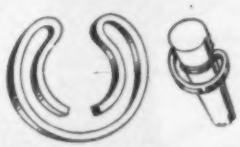
1 foot lengths Compression Springs suitable for cutting into shorter lengths. Assorted diameters from ½" to ½" and 24 to 16 S.W.G. **4/6 per box containing 1 dozen lengths.**



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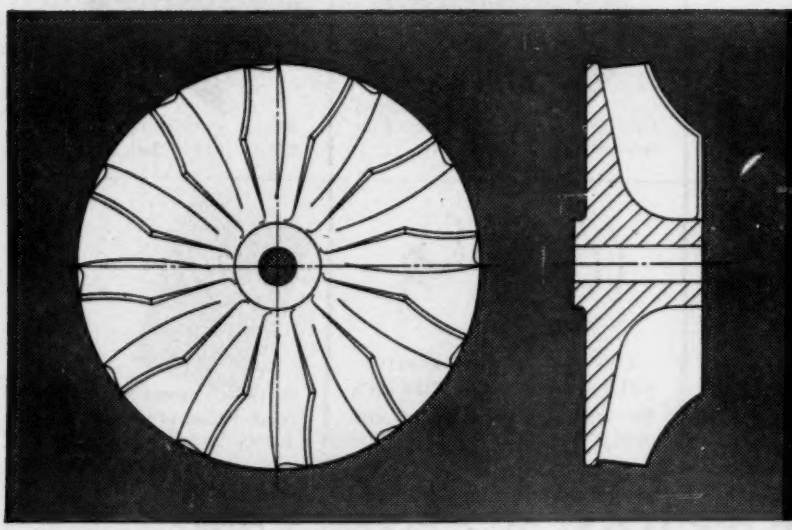

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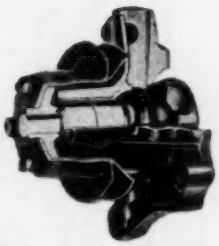

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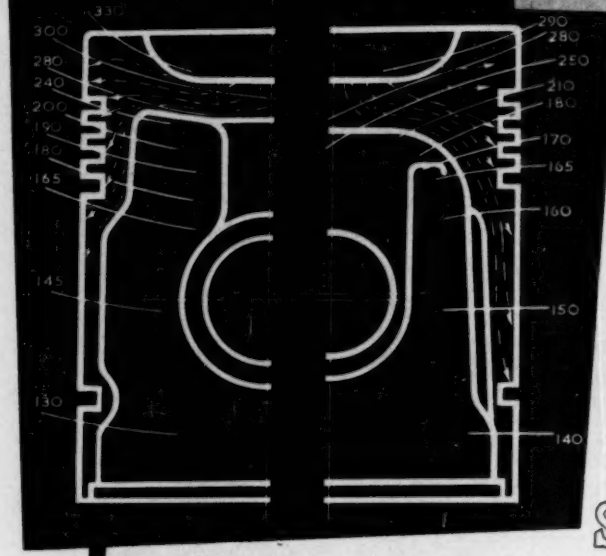

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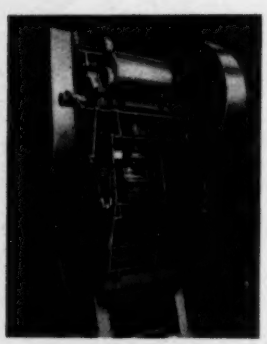

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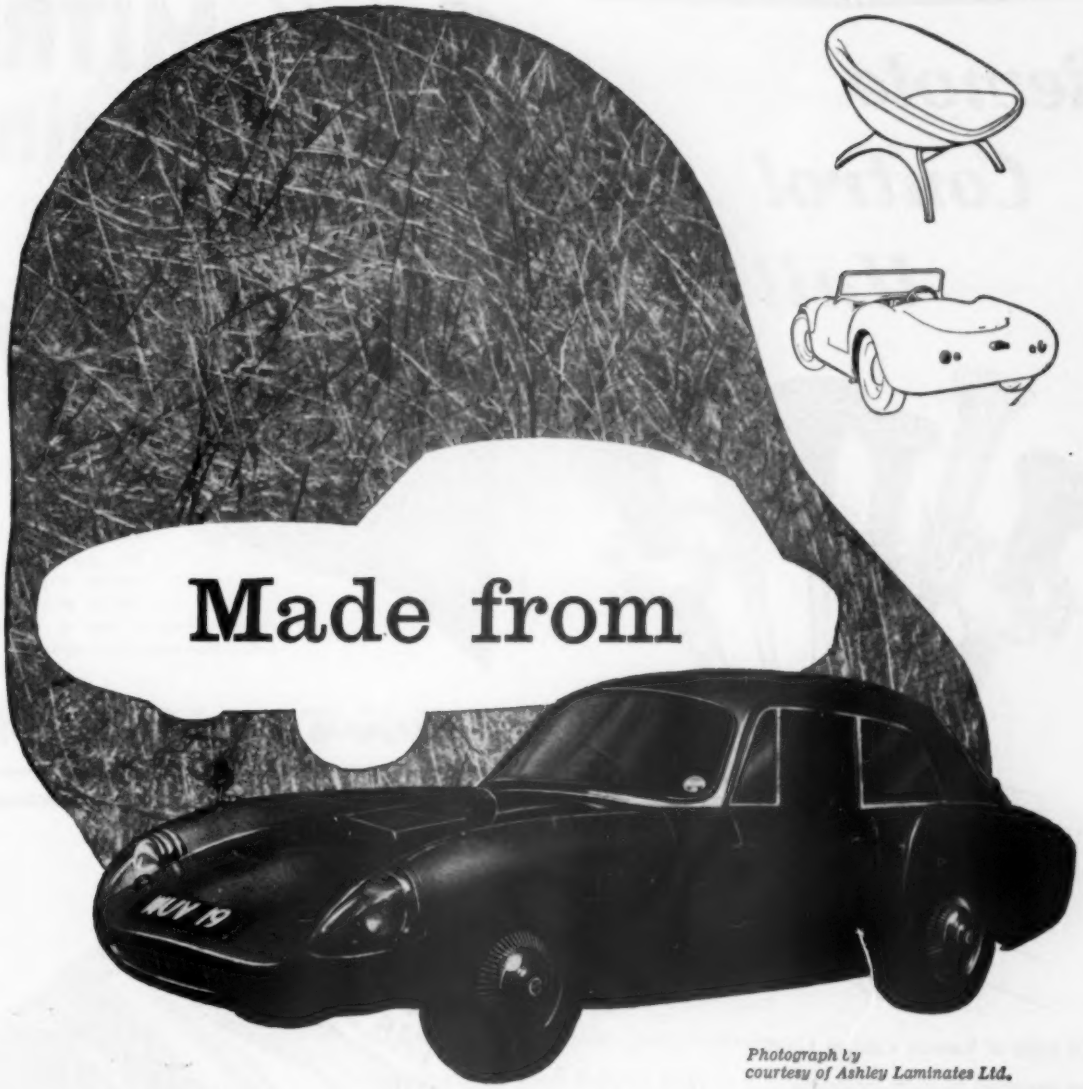

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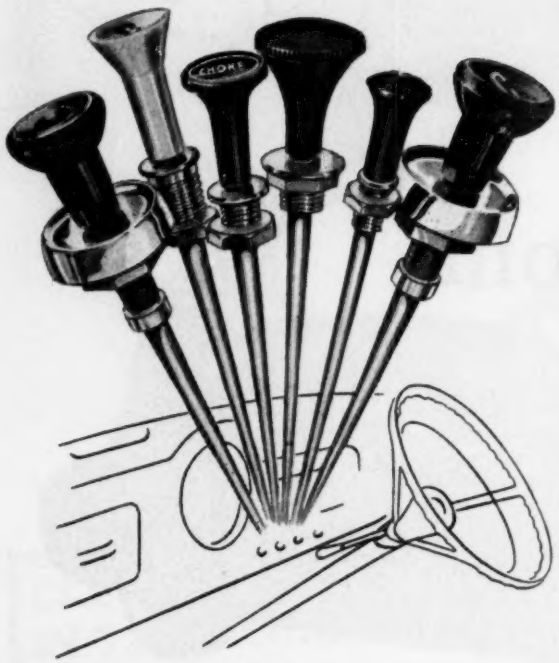

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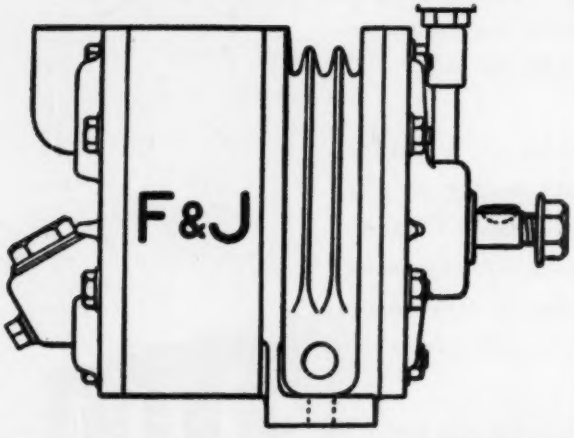

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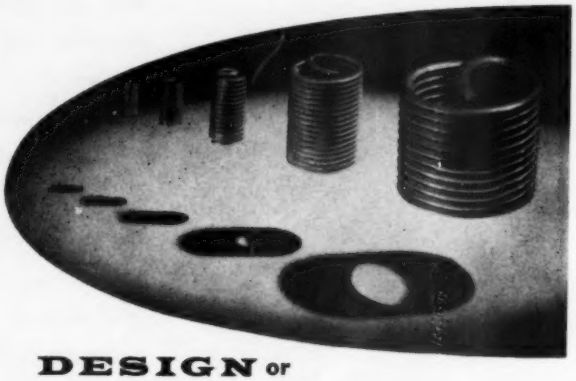

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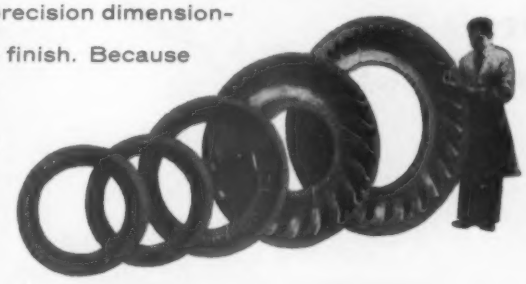

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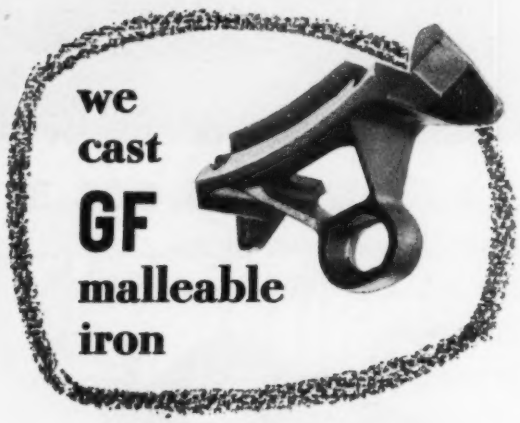

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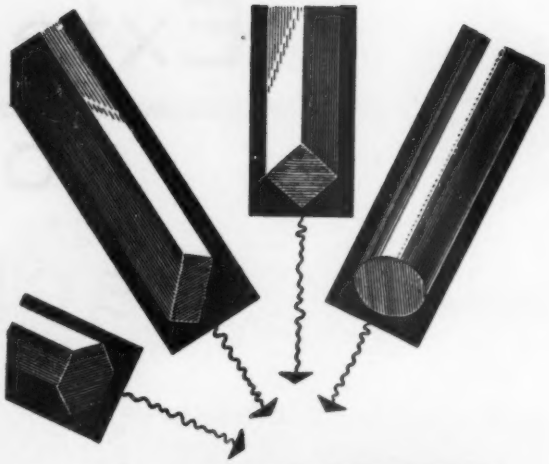

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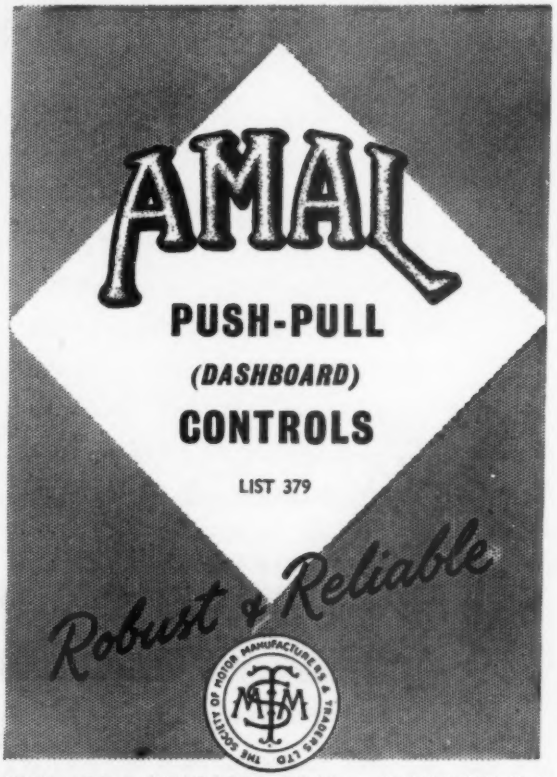

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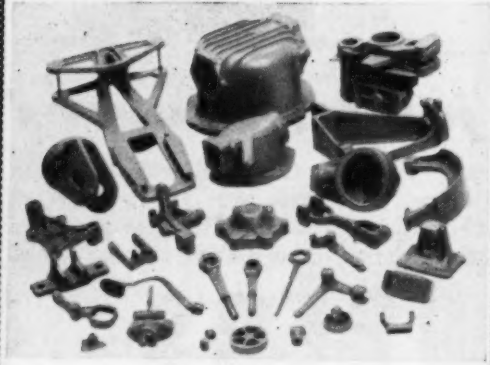

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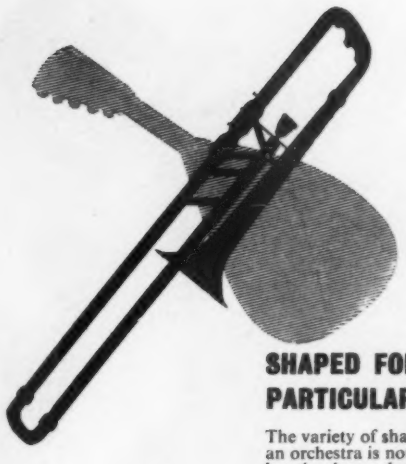

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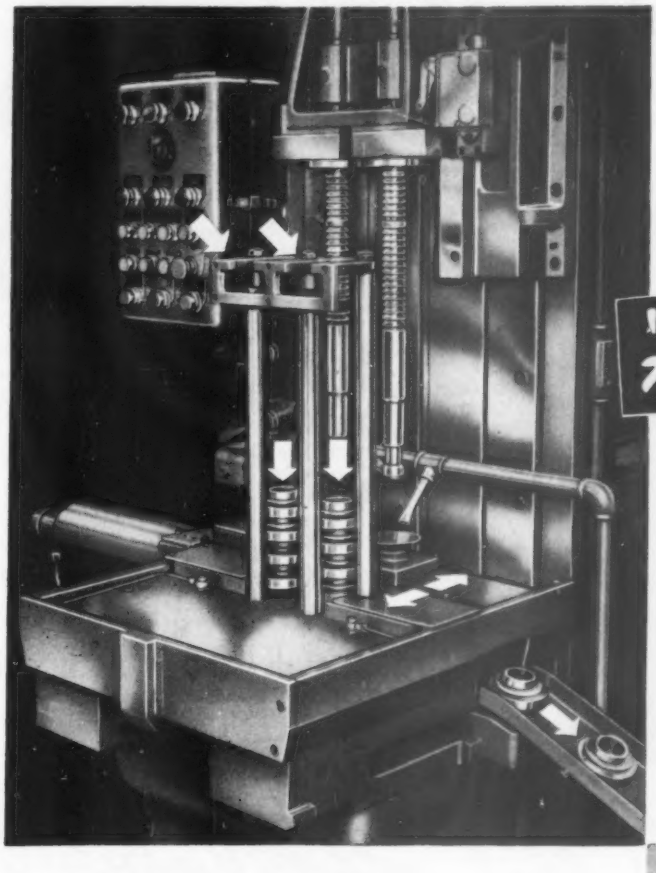

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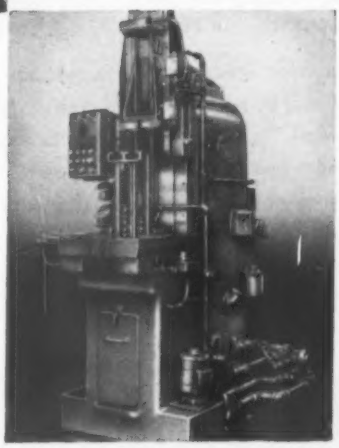

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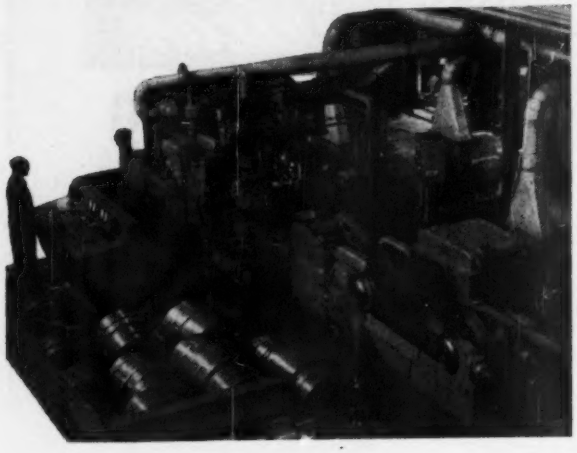

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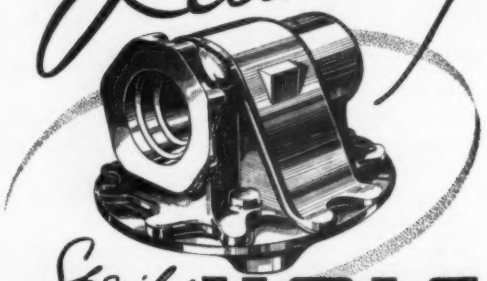

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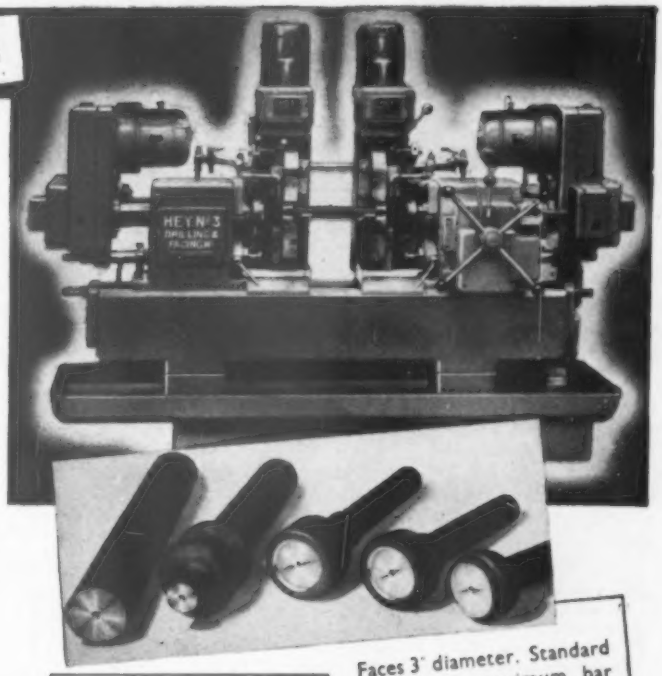

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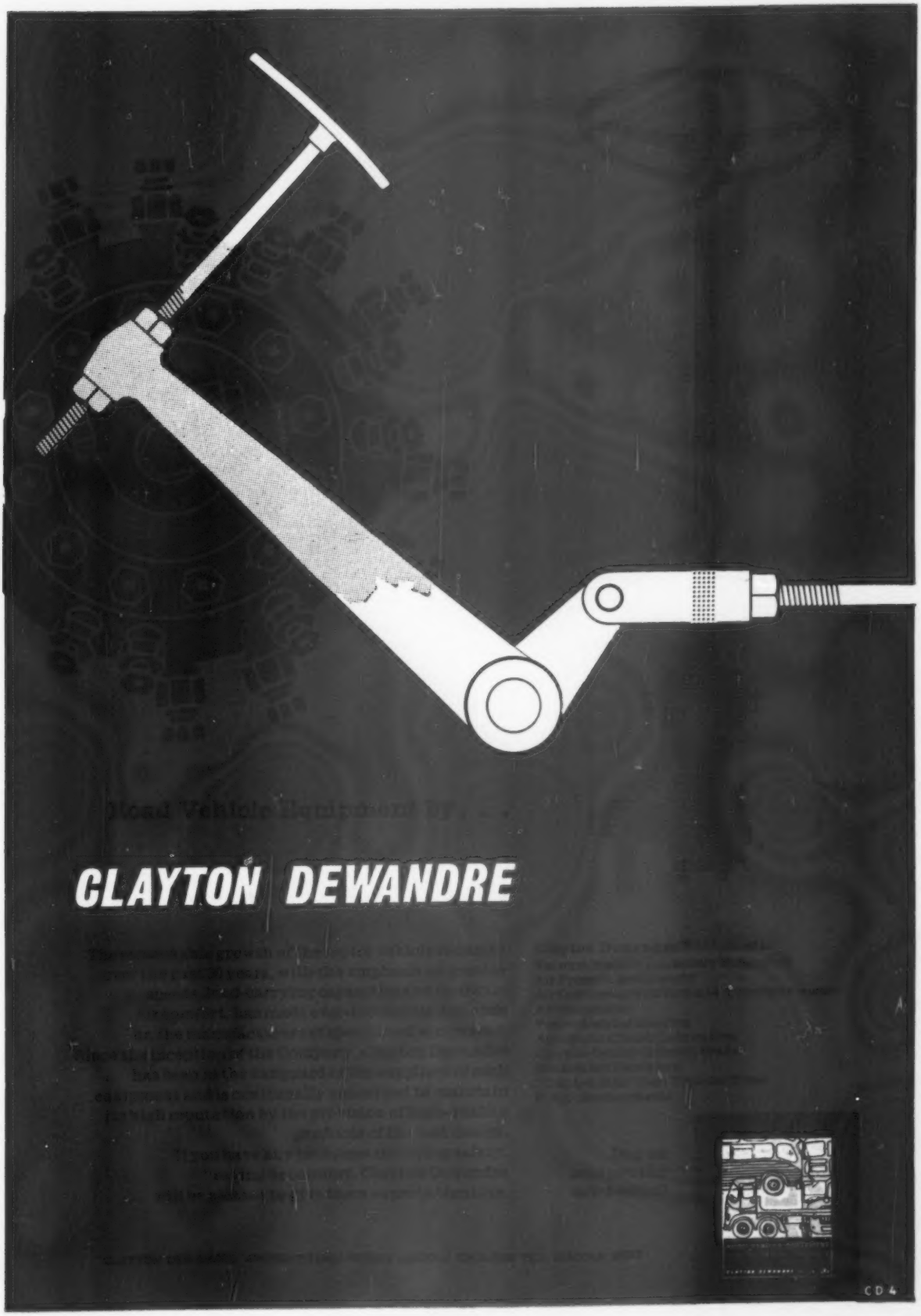
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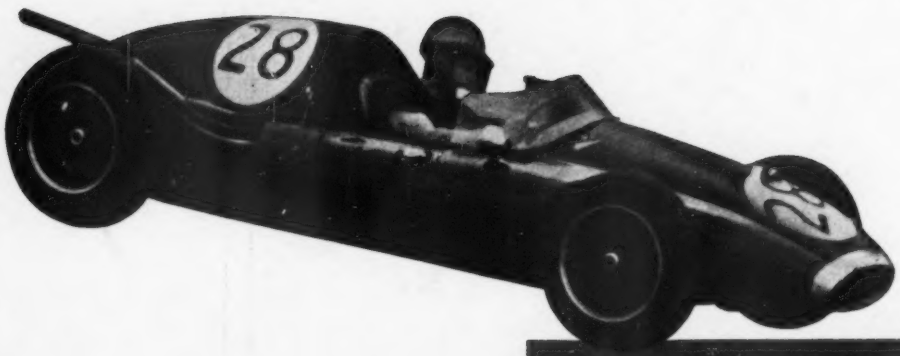

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